Teachers' use of research on teaching critical thinking. A collaborative way to link teachers' use and production of research and knowledge.

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Frontières de l'Innovation en Recherche et Education (FIRE) – ED 474

System Engineering and Evolution Dynamics, INSERM

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Thèse de doctorat de **Sociologie et sciences de l'éducation**

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Présentée et soutenue publiquement le **7 octobre 2024**

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Titre :
L'utilisation par les enseignant·es de recherches sur l'éducation à l'esprit critique. Une approche collaborative pour lier l'utilisation et la production par les enseignant·es de recherches et de connaissances.

Résumé :

Cette thèse traite, à travers cinq études, du concept d'utilisation par les enseignant·es de recherches et de la manière de faciliter une telle utilisation pour l'éducation à l'esprit critique.

La première étude examine les opinions d'acteur·rices de l'éducation concernant les facteurs influençant l'utilisation par les enseignant·es de recherches qui sont entre les mains de chercheur·euses et de décideur·euses. Cette enquête factorielle avec 440 répondant·es révèle des opinions divergentes parmi les enseignant·es, formateur·rices, décideur·euses et chercheur·euses, avec toutefois un consensus général sur l'importance du soutien institutionnel et des éléments facilitant l'utilisation instrumentale des recherches. Cette étude souligne l'importance d'une meilleure clarté du concept d'utilisation par les enseignant·es de recherches.

La deuxième étude approfondit les ambiguïtés conceptuelles des notions de recherche, preuve, données et connaissances et leur utilisation en éducation. Cette revue systématique de 32 revues de la littérature identifie un manque de définitions claires. Elle identifie également l'importance de redéfinir les rôles, souvent asymétriques, des enseignant·es et chercheur·euses, et souligne la nécessité de changements culturels, infrastructurels et systémiques pour soutenir l'utilisation et la production de recherches par les enseignant·es de façon horizontale..

La troisième étude décrit un projet de recherche orienté par la conception visant à faciliter l'utilisation par les enseignant·es de recherches sur l'éducation à l'esprit critique. Cette étude analyse la création d'une ressource appuyée par la recherche impliquant plus de 30 chercheur·euses et enseignant·es. Elle documente également un réseau de recherche par les enseignant·es, dédié à l'éducation à l'esprit critique, et son interconnexion réussie avec la ressource. L'étude suggère l'évaluation future de leur usage lors de formation d'enseignant·es.

La quatrième étude discute du fossé entre enseignement et recherche, sous le prisme des 'deux communautés'. Elle s'interroge sur les motivations des

enseignant·es et des chercheur·euses à s'engager dans une recherche collaborative à travers une enquête exploratoire. Elle révèle que les récompenses ou les contraintes professionnelles, et le temps nécessaire pour participer à des recherches collaboratives, sont de faibles sources de motivation. Les résultats similaires du côté des enseignant·es et des chercheur·euses remettent en question le cadre des 'deux communautés'. L'étude recommande de détailler les étapes des recherches collaboratives pour mieux comprendre les moteurs de participation.

La cinquième étude aborde la reconceptualisation de l'éducation à l'esprit critique en éducation aux approches critiques, basée sur les limitations liées au premier concept. La littérature examinée montre une prédominance des compétences d'esprit critique au détriment des dispositions et une surestimation de la dimension épistémique par rapport aux dimensions éthiques et politiques. Cette étude questionne également les pratiques d'évaluation dominantes dans le domaine, principalement à travers des tests standardisés. L'éducation aux approches critiques est proposée pour pallier ces lacunes et se concentre sur quatre axes décrits dans la ressource produite dans le cadre d'une recherche orientée par la conception. La ressource opérationnalise l'éducation aux approches critiques à travers le rapport aux savoirs, la métacognition et la réflexivité, l'argumentation et l'évaluation de l'information.

En résumé, cette thèse propose une analyse détaillée de la facilitation de l'utilisation par les enseignant·es de recherches, en mettant l'accent sur la recherche collaborative, la clarification conceptuelle et le soutien institutionnel, en particulier pour l'utilisation par les enseignant·es de recherches sur l'éducation aux approches critiques.

Mots clefs : utilisation de recherches, éduquer à l'esprit critique, recherche orientée par la conception, Profs-Chercheurs, partenariats recherche-pratique

Title:
Teachers' use of research on teaching critical thinking. A collaborative way to link teachers' use and production of research and knowledge

Abstract:

Through five interconnected studies, this dissertation explores the multifaceted concept of teachers' use of research, and how to facilitate such use on teaching critical thinking.

The first study investigates educational stakeholders' views about factors influencing teachers' use of research, focusing on factors that researchers and decision-makers can act upon. This factorial survey experiment with 440 participants reveals some differing opinions among teachers, trainers, decision makers, and researchers, with a consensus that institutional support and elements facilitating the instrumental use of research are most important. This study suggests that better conceptual clarity is needed about teachers' use of research.

The second study further examines the conceptual ambiguities of research, evidence, data, and knowledge and their use in education. This systematic review of 32 reviews identifies a lack of clear definitions, especially regarding the educational goals associated with teachers' use of research, evidence, data, and knowledge. It also suggests redefining teachers' and researchers' usually asymmetrical roles, and proposes cultural, infrastructural, and systemic changes for sustained research use by teachers, advocating for two-way horizontal approaches linking teachers' use and production of research.

The third study reviews collaborative frameworks to support teachers' use of research and describes a design-based research project aiming at facilitating teachers' use of research on teaching critical thinking. This study analyzes the creation of a research-brokered resource that involved over 30 researchers and teachers. The steps involved a review of a previous research-based resource unsuited to teachers and in-person meetings to sort and prioritize suggested changes. It also documents a teacher-research network dedicated to teaching critical thinking and details its successful interconnection with the resource. The study suggests that future research should examine their effect on teachers' use of research on teaching critical thinking as part of a teacher training program.

The fourth study discusses the gap between teaching and research, and the associated 'two-communities framework'. It questions teachers' and researchers' motivations for engaging in collaborative research through an exploratory survey. It reveals that rewards or professional constraints and the time needed to take part in collaborative research are lower sources of motivation compared to others such as the perceived usefulness of the result or process, or clear and explicit goals. The findings challenge the 'two-communities' framework, showing that there are many shared motivations between teachers and researchers. The study recommends detailed descriptions of collaborative project steps to better understand what drives participation.

The fifth study addresses the reconceptualization of teaching critical thinking into teaching critical approaches, based on limitations found regarding the former concept. The literature reviewed shows a predominant focus on critical thinking skills over dispositions and an overemphasis on the epistemic rather than the ethical and political dimensions. This study also critiques the dominant evaluation practices in the field, which are mostly through standardized testing. Teaching critical approaches is suggested to address these pitfalls and focuses on four axes described in the resource produced as part of a design-based research. The resource operationalizes teaching critical approaches through focus on the relationship to knowledge, metacognition and reflexivity, argumentation, and information evaluation.

Overall, this dissertation provides a comprehensive examination of facilitating teachers' use of research, emphasizing collaborative research frameworks, conceptual clarification and institutional support to sustain teachers' use of research, particularly in relation to teaching critical approaches.

Keywords : teachers' use of research, teaching critical thinking, design-based research, teacher-research, research-practice partnerships

Résumé substantiel en français

Cette thèse s’inscrit dans un champ de recherche s’intéressant à l’utilisation par des enseignant·es de recherches en éducation. Il existe de nombreuses façons dont cette utilisation de recherches est conceptualisée, et l’une des plus communément partagées est celle proposée par Weiss et Bucuvalas qui distinguent utilisation instrumentale, conceptuelle et symbolique. L'utilisation instrumentale de la recherche correspond à la prise de décision ou à la résolution de problèmes directement informée par la recherche ; l'utilisation conceptuelle de la recherche correspond au changement d'idées ou à la réflexion sur un sujet après s'être engagé dans la recherche ; l'utilisation symbolique de la recherche correspond à la justification appuyée par la recherche de décisions et d'actions déjà prises.

Dans le cadre du premier article de cette thèse, nous nous appuyons sur cette conception d’utilisation de recherches, en particulier l’utilisation instrumentale et conceptuelle. Nous nous intéressons à ce que les différents acteur·rices de l'éducation, pensent de certains facteurs qui peuvent influencer l'utilisation de recherches par les enseignant·es. Afin d'éviter de produire une recherche qui conclurait sur ce que les enseignant·es devraient faire ou changer, nous nous sommes plutôt concentré sur les facteurs sur lesquels les chercheur·euses ou les décideurs en matière d'éducation pourraient agir (par exemple, rédiger des recherches adaptées à un public d'enseignant·es ou apporter un soutien institutionnel à l'utilisation de recherches par les enseignant·es), mais pas sur les caractéristiques des enseignant·es, bien qu’elles jouent un rôle. Ces facteurs, sélectionnés suite à un travail incluant des enseignant·es et autres acteur·rices de l’éducation, sont: adaptation à un public d’enseignant·es; implication d’enseignant·es dans la production de recherches; intégration d’éléments susceptibles de faciliter une utilisation conceptuelle; intégration d’éléments susceptibles de faciliter une utilisation instrumentale; opportunités pour collaborer autour de l’utilisation de recherches; ayant du support institutionnel pour l’utilisation de recherches. Chacun de ces facteurs pouvait prendre deux valeurs (positive et négative). Parmi ce sous-ensemble de facteurs,nous nous sommes demandé lesquels étaient perçus comme contribuant le plus à faciliter ou empêcher l’utilisation par les enseignant·es de recherches en éducation, et en particulier s’il existait des différences entre les répondants selon leur rôle (enseignant·es, chercheur·euses, personnel de soutien en contact direct avec les enseignant·es et décideurs n’ayant pas de contact direct avec les enseignant·es).

Pour répondre à cette question, nous avons réalisé une enquête factorielle expérimentale. À partir des six facteurs, nous avons construit l'ensemble des vignettes mettant en scène des situations fictives dans lesquelles on présentait les six facteurs dans leur version soit positive, soit négative. Nous avons restreint l'ensemble des vignettes à un sous-ensemble représentatif de 16 vignettes, réparties en deux blocs équivalents de 8 vignettes, que nous avons intégrés dans un questionnaire. Ce questionnaire recueillait des données démographiques – notamment le rôle des répondant·es – et présentait successivement les 8 vignettes aux participant·es en leur demandant de juger dans quelle mesure il était probable que l'enseignant·e imaginaire de la vignette utilise ou non les recherches en éducation. Une analyse avec un modèle linéaire multiniveau a été réalisée d'abord avec une étude pilote ($N = 100$) qui a permis de générer des hypothèses précises, puis l'étude complète ($N = 340$). Nos résultats indiquent notamment que les facteurs relatifs à la facilitation de l'utilisation instrumentale ainsi qu'au soutien institutionnel sont jugés comme jouant un rôle plus important que les autres. Quant aux interactions entre les réponses et le rôle, plusieurs différences de jugement ont été relevées, comme par exemple le fait qu'en moyenne, les enseignant·es jugent significativement moins probable l'utilisation par les enseignant·es de recherches que les chercheur·euses ou personnel de soutien en contact direct avec les enseignant·es. D'autres différences ont été relevées à l'échelle de facteurs spécifiques, comme les chercheur·euses qui jugent moins que les autres que la participation des enseignant·es à la production de recherches influence leur utilisation de recherches. Enfin, nous n'avons trouvé aucun effet significatif du nombre d'années d'expérience sur les réponses des participant·es. Nous tirons de cette première étude deux leçons qui ont influencé le reste du travail : premièrement, il existe des différences entre les jugements attribuables aux rôles, ce qui semble aller dans le sens d'une théorie distinguant plusieurs communautés, mais en réalité il ne semble pas se détacher uniquement deux communautés, comme c'est souvent théorisé en opposant chercheur·euses et praticien·nes, mais bien quatre. De plus, ce résultat est à nuancer puisque l'influence du rôle dans les réponses ne concerne pas forcément tous les facteurs. Deuxièmement, nos résultats pointent une interaction statistiquement significative entre les jugements concernant l'utilisation conceptuelle et instrumentale. Cela peut être interprété comme une mauvaise conceptualisation dans le modèle sur lequel nous nous appuyons, puisque les deux ne sont pas indépendants: on peut par exemple penser qu'une utilisation conceptuelle (changer ses idées) serait nécessaire pour mener à une utilisation instrumentale (changer ses pratiques).

Dans le cadre du deuxième article de cette thèse, nous sommes partis du constat que de nombreuses recherches proposent des cadres conceptuels différents pour penser l'utilisation par des enseignant·es de recherches en éducation. La littérature scientifique dans ce champ évoquant notamment le caractère flou et contesté des définitions de recherches ou de leur utilisation, nous avons décidé de considérer une vision assez large de ce que peuvent être des recherches. En plus du terme recherches (*research*), nous avons donc considéré différents termes s'en rapprochant: données probantes ou preuves (*evidence*), données (*data*) et savoirs ou connaissances (*knowledge*) pour former l'acronyme REDaK qui regroupe les quatre termes. Plusieurs articles ont par ailleurs questionné les buts éducatifs pour l'utilisation de recherches, avec une critique forte du mouvement de l'éducation fondé sur des données probantes (*evidence-based education*), souvent associé à une vision descendante de l'utilisation de recherches. Des visions critiques ont mis en avant les enjeux de pouvoirs dans les relations entre le monde de la recherche et des pratiques éducatives, et d'autres ont questionné les enjeux d'équité pour les élèves. Nous avons donc décidé d'intégrer à notre réflexion la question des buts éducatifs pour l'utilisation par des enseignant·es de recherches en éducation. Enfin, de nombreux articles ont souligné la question des rôles des enseignant·es et des chercheur·euses, ainsi que des systèmes et infrastructures jouant un rôle pour l'utilisation par des enseignant·es de recherches en éducation. Souhaitant également questionner cet aspect, nous nous sommes demandé comment les chercheur·euses conceptualisent les REDaK, leur utilisation, les buts éducatifs associés, et le rôle des acteur·rices de l'éducation ainsi que des systèmes et infrastructures dans lesquels ces acteur·rices agissent. Enfin, nous nous sommes demandé s'il existe des rapprochements à faire entre différentes visions de ces quatre axes. Pour répondre à ces questions, nous avons réalisé une revue systématique des revues de la littérature dans le champ de l'utilisation par des enseignant·es des REDaK. Nous avons choisi de nous concentrer sur les revues de la littérature parce qu'elles sont souvent plus citées et guident le champ de recherche.

Nous avons inclus un total de 32 revues de la littérature dans notre revue systématique, dont un grand nombre mentionnait plusieurs REDaK. Les deux conceptions d'utilisation de REDaK les plus fréquentes concernent la prise de décision fondée sur des données, et les partenariats recherche-pratique. Seuls 13 articles ont explicitement défini au moins un REDaK, 18 au moins une forme d'utilisation de REDaK, et 5 ont défini des buts éducatifs liés à l'utilisation de

REDaK. Nous avons relevé de nombreux termes décrivant la qualité des REDaK, ou ce qui témoignerait d'une utilisation de qualité, tandis que les termes utilisés pour parler des buts éducatifs sont pour la plupart très vagues. Concernant les rôles, notre revue systématique a trouvé des descriptions en tensions concernant la profession enseignante, tantôt décrivant les enseignant·es comme des professionnel·les compétent·es, tantôt comme des individus peu préparés et nécessitant une formation. À l'inverse, les chercheur·euses sont souvent décrit·es comme produisant les REDaK et étant des expert·es. Cependant, nous avons relevé un nombre important de critiques des rôles rigides, et des appels à la redéfinition et la négociation, voire la création de nouveaux rôles, soulignant l'importance d'un rôle de passeur, ayant l'expérience des deux cultures, ou de leadership pour faciliter l'utilisation par des enseignant·es de REDaK. Enfin, le rôle central d'une évolution de culture, d'infrastructures ou d'éléments systématiques a été maintes fois soulevé. Cela nous a finalement permis de dégager quatre tendances ou archétypes liés à l'utilisation par les enseignant·es de REDaK. Nous avons conclu ce travail en rappelant l'importance de mieux définir les concepts mobilisés, et en particulier concernant les buts éducatifs sous-jacents. Ce travail peut contribuer à de futures recherches, notamment pour explorer au-delà des revues de littérature si de tels écueils sont également présents dans les recherches primaires. Il peut également contribuer à mieux structurer et documenter d'éventuelles collaborations ou partenariats entre le monde académique et celui des pratiques éducatives. Nous espérons que notre revue systématique contribuera à sortir des visions non seulement problématiques politiquement, comme les approches très verticales, de dissémination des recherches, afin qu'elles soient remplacées par des approches plus horizontales et dialogiques, tenant compte des problèmes structurels à l'utilisation par des enseignant·es de recherches en éducation. À ce titre, nous proposons un 'méta-cadre' dans lequel plusieurs formes de recherches partenariales ou collaboratives peuvent s'inscrire, tout en rappelant que son utilisation n'a de sens qu'à la condition d'un soutien institutionnel fort.

Dans le cadre du troisième article de cette thèse, nous avons centré notre réflexion sur la spécificité de l'éducation à l'esprit critique dans l'optique de faciliter l'utilisation par des enseignant·es de recherches en éducation. Partant tout d'abord de plusieurs modèles prometteurs pour une recherche collaborative horizontale, telle que suggérée dans notre revue systématique de la littérature, nous avons en particulier étudié les partenariats recherche-pratiques (*research-practice*

partnerships), le courtage en connaissances (*knowledge brokering* ou *brokerage*) et la

recherche orientée par la conception (*design-based research*). En particulier, nous avons évoqué le potentiel des recherches orientées par la conception pour la production de ressources issues d'un courtage en connaissances, c'est-à-dire proposant une nouvelle forme de connaissances à mi-chemin entre les recherches et les pratiques (*brokered knowledge*). En plus de telles ressources, nous avons mis de l'avant le rôle essentiel de réseaux, complémentaires à la création de ressources qui sont majoritaires dans le champ des activités de courtage en connaissances. Nous avons donc étudié les ressources et les réseaux existants dédiés à l'éducation à l'esprit critique, et avons proposé de partir d'une ressource existante, issue de recherches scientifiques mais peu adaptée à un public enseignant. Nous nous sommes demandés quelles caractéristiques d'une telle ressource pouvait être perçue par des enseignant·es et des chercheur·euses comme adaptée à un public d'enseignant·es, mais aussi comme susceptible de faciliter une utilisation conceptuelle ou instrumentale de recherches. Étant donné notre objectif de produire une ressource plus adaptée selon ces critères, nous avons également questionné la capacité de cette nouvelle ressource à intégrer de telles caractéristiques. Enfin, nous nous sommes demandé dans quelle mesure la ressource produite et le réseau dédié à l'éducation à l'esprit critique que nous avons coordonné pouvaient être reliés.

Notre travail a pris la forme d'une recherche orientée par la conception à laquelle ont participé une trentaine de chercheur·euses et d'enseignant·es à travers plusieurs étapes. La première étape a consisté à faire relire la ressource initiale, et à extraire de l'ensemble des rapports de relecture les changements suggérés. Ces changements suggérés ont ensuite été catégorisés et regroupés, puis nous avons organisé trois rencontres d'une journée pour faire un tri et prioriser les changements suggérés pour la conception d'une nouvelle ressource. Lors de la première journée de rencontre, nous avons concentré nos efforts sur les changements suggérés relatifs aux contenus; lors de la deuxième journée, sur les changements suggérés relatifs aux exemples concrets de pratiques éducatives; et lors de la troisième journée, sur la structure et le design pour la nouvelle ressource. En parallèle de ce travail, nous avons également coordonné et facilité des temps de deux heures d'ateliers en ligne au sein d'un réseau inspiré du mouvement de recherche enseignante (*teacher research*). Lors de ces ateliers, les participant·es

étaient invité·es à documenter leurs défis en lien avec l'éducation à l'esprit critique et à proposer des pistes d'actions pour relever ces défis. Enfin, m'appuyant sur tout ce travail et avec l'aide d'un facilitateur graphique, nous avons réécrit puis mis en page une nouvelle ressource illustrée.

L'analyse d'un grand nombre de changements suggérés (N = 805) a révélé qu'une majorité des changements attendus visaient à rendre la nouvelle ressource plus adaptée à un public d'enseignant·es (N = 462), une partie conséquente à faciliter une utilisation instrumentale de celle-ci (N = 240), et une minorité à en faciliter une utilisation conceptuelle (N = 103). Parmi les groupes de changements suggérés traités lors de la première journée de rencontre (N = 206), une majorité a été partiellement (N = 17) ou totalement (N = 92) intégrés dans la nouvelle ressource. Parmi les groupes qui n'ont pas été intégrés (N = 89), une grande partie (N = 53) est due aux changements dans l'écriture qui font que certains changements suggérés sont devenus obsolètes. Globalement, les changements effectués ont largement tenu compte des priorités évoquées lors de cette journée de rencontre. Ce travail contribue à répondre positivement à notre deuxième question concernant la possibilité d'intégrer des modifications permettant d'améliorer la ressource au regard de son adaptation pour un public enseignant ou pour faciliter une utilisation conceptuelle de celle-ci. Le travail lors de la deuxième journée de rencontre n'a permis de traiter en profondeur que 7 des 240 pistes d'exemples concrets, et leur développement a finalement été intégré aux défis et actions du réseau dédié à l'éducation à l'esprit critique, donc 3 sur les 7 ont été retravaillés au sein du réseau. Ce réseau a quant à lui proposé 15 défis et 9 pistes d'action, dont une analyse de la complétion a révélé leur potentiel non seulement pour faciliter une utilisation conceptuelle et instrumentale de recherches, mais également une utilisation processuelle, ce qui correspond à l'apprentissage des méthodes de recherche lors de l'engagement dans la recherche. Parmi l'ensemble des défis et pistes d'actions proposées par le réseau, la nouvelle ressource a intégré 7 de ces défis et 4 pistes d'actions, contribuant à montrer le potentiel du réseau à nourrir la ressource. À l'inverse, suite à la réécriture du contenu, notre facilitation des ateliers en ligne au sein du réseau ont également pu être nourris par le contenu de la nouvelle ressource, illustrant la double synergie entre la ressource et le réseau. Finalement, à l'aide de la troisième journée de rencontre qui a permis d'affiner la structure prévue pour la nouvelle ressource et grâce au travail avec le facilitateur graphique, nous avons intégré à la nouvelle ressource une structure et de nombreuses

illustrations et schémas, témoignant de sa meilleure adaptation à un public-cible d'enseignant·es.

Ce travail a permis de voir comment une recherche orientée par la conception d'une ressource, croisée avec la facilitation d'un réseau, peuvent permettre de faciliter l'utilisation par des enseignant·es de recherches sur l'éducation à l'esprit critique. De futures recherches pourront évaluer l'intérêt de la combinaison de la nouvelle ressource et du réseau qui lui est associé en vue de proposer des formations d'enseignant·es sur l'éducation à l'esprit critique.

Dans le cadre du quatrième article de cette thèse, nous décrivons un travail réalisé dans le cadre de cette même recherche orientée par la conception, mais en s'intéressant plus spécifiquement aux motivations des enseignant·es et des chercheur·euses à s'engager dans différentes étapes d'une telle recherche collaborative, ou de recherches collaboratives en général. Nous avons d'abord présenté la littérature scientifique décrivant un fossé entre les chercheur·euses et les enseignant·es, et proposant régulièrement une conception qui oppose deux communautés (celle des chercheur·euses et celle des enseignant·es ou praticien·nes). Étant donné que plusieurs formes de recherche collaborative semblent prometteuses pour rapprocher ces deux communautés, il nous a semblé important de questionner ce qui motive chacun des deux groupes à s'engager dans de telles recherches collaboratives. Pour cela, nous nous sommes grandement appuyés sur un travail qui s'intéressait exclusivement à la motivation des enseignant·es, et avons choisi de l'adapter pour qu'il permette de comparer les motivations des enseignant·es avec celles des chercheur·euses. Nous nous sommes d'abord demandé ce qui motive les enseignant·es et les chercheur·euses à participer dans différentes étapes de recherche collaborative orientée par la conception, indépendamment de leur rôle, puis nous nous sommes demandé s'il existe des différences de motivations entre ces deux groupes. Enfin, nous avons souhaité savoir s'il existait un lien entre la motivation et la participation effective aux différentes étapes de notre recherche orientée par la conception.

Nous avons donc conçu un questionnaire afin de réaliser une étude exploratoire auprès des enseignant·es et des chercheur·euses ayant participé à une ou plusieurs étapes de notre recherche orientée par la conception, ainsi qu'à d'autres personnes ayant indiqué un intérêt pour contribuer. En plus des questions démographiques

portant notamment sur le rôle, notre questionnaire intégrait quatre sections. La première portait sur les motivations à participer, de façon générale, à des recherches collaboratives. La deuxième portait sur les motivations à participer à l'étape de révision de la ressource initiale. La troisième portait sur les motivations à participer aux activités sur réseau dédiée à l'éducation à l'esprit critique. La

quatrième portrait sur les motivations à participer aux journées de rencontre pour faire le tri et prioriser les changements suggérés lors de la révision de la ressource initiale. Précisons que la période de réponse au questionnaire était après la fin de la révision, pendant la période d'activité du réseau, et avant les journées de rencontre. À ce titre, bien que par construction nous ayons visé à avoir des formulations similaires pour chacune des 10 questions intégrées dans chaque section, elles ont nécessairement varié légèrement pour tenir compte de la dimension temporelle.

Les réponses au questionnaire ($N = 30$) ont permis d'identifier que parmi les 10 sources présumées de motivation correspondant à chacune des 10 questions, les motivations extrinsèques (récompenses ou contraintes professionnelles) et, dans une moindre mesure, le temps nécessaire à la participation aux étapes de recherche collaborative, étaient les deux éléments jugés comme influençant le moins les motivations. Alors que de nombreuses recherches témoignent du manque de temps des enseignant·es pour participer à des recherches collaboratives notamment, ce résultat surprenant pourrait être interprété en différenciant la motivation à participer et la participation effective. En effet, la motivation des répondant·es pourrait être inchangée si de telles collaborations prennent beaucoup de temps, mais simplement être dans l'incapacité de s'engager pour des raisons extérieures à leur motivation. En comparant les réponses des enseignant·es et des chercheur·euses, nos résultats n'ont dans l'ensemble pas permis de repérer de différences statistiquement significatives. Notre faible échantillon ne nous permettant pas de conclure à l'absence de différences de motivations, nous pouvons simplement déduire que, s'il existe une réelle différence de motivation entre ces deux communautés, alors elle est vraisemblablement assez faible. Enfin, nous avons remarqué que les réponses au questionnaire étaient significativement prédites par le degré de participation effective à la première étape, soit la révision de la ressource. Par contre, nous n'avons pas détecté de lien similaire avec la participation au réseau dédiée à l'éducation à l'esprit critique. Enfin, nos résultats indiquent que les réponses à deux questions de la quatrième section du questionnaire permettaient de prédire en

partie la participation aux journées de rencontre. En particulier, les résultats suggèrent que moins il est important pour les répondants de choisir les moments de collaboration et de travail en autonomie, plus leur participation est élevée. Par ailleurs, plus il est important pour les répondants que le résultat ou le processus de cette étape de recherche collaborative leur soit utile, plus leur participation est élevée.

Finalement, notre enquête exploratoire a permis d'apporter une nuance à la conception des enseignant·es et des chercheur·euses en deux communautés distinctes, et ouvre la voie pour de nouvelles recherches sur les motivations comparées entre enseignant·es et chercheur·euses dans le cadre de recherches collaboratives.

Dans le cadre du cinquième article de cette thèse, nous souhaitions présenter à des chercheur·euses l'aboutissement théorique sur l'éducation à l'esprit critique du travail mené dans le cadre de notre recherche orientée par la conception. En effet, nous avons développé une ressource à destination d'un public enseignant, et nous avons proposé dans cette ressource de parler plutôt d'éducation aux approches critiques par les élèves. Cet article théorique s'appuie sur la littérature dans le champ de l'éducation à l'esprit critique et en souligne des limites ou problèmes récurrents, identifiés et partagés par de nombreux·ses chercheur·euses. Par exemple, nous rejoignons le relatif consensus qui consiste à découper l'esprit critique en un ensemble de connaissances (*knowledge*), compétences (*skills*) et dispositions (*dispositions*). Cependant, de nombreux travaux ont montré la surreprésentation de recherches portant sur le développement et la mesure des compétences, et non des dispositions. Notre argumentation porte sur le fait qu'évaluer rigoureusement ces dispositions, en particulier avec des méthodes quantitatives, est plus difficile comparé à l'étude des compétences. De plus, des approches de l'éducation à l'esprit critique se concentrent parfois sur la dimension épistémique (distinguer le vrai du faux) et laissent de côté les enjeux éthiques ou politiques. Or, une définition assez classique de l'esprit critique, portant sur l'enjeu de quoi croire ou quoi faire, on comprend que les enjeux éthiques ou politiques sont indissociables de la réflexion sur *quoi faire* en particulier, avec l'importance de tenir compte du contexte et des conséquences de nos actions. Enfin, nous revenons sur l'objectif final d'une éducation à l'esprit critique : le transfert des compétences développées dans un contexte *X* à un autre contexte *Y*. Non seulement au regard

de la littérature, il nous semble que cette métaphore est vague mais qu'elle risque également d'induire en erreur en réifiant l'esprit critique, comme si on l'avait acquis, et qu'il suffisait de le réactiver dans un nouveau contexte.

Face à ces problèmes largement documentés, notre proposition d'éducation aux approches critiques permet tout d'abord de s'affranchir de la vision traditionnelle de l'esprit critique naturalisé et réifié, mais permet par exemple de considérer une approche critique mobilisée par un groupe plutôt qu'un individu. Par ailleurs, nous centrons l'éducation aux approches critiques sur un travail autour de dispositions,

sur la co-intégration des dimensions épistémiques, éthiques et politiques – par exemple avec les prisme des questions socio-scientifiques – et nous proposons la notion de mobilisation transversale pour remplacer la métaphore du transfert, soulignant cette fois l'idée que dans un même contexte, plusieurs approches différentes peuvent être également critiques (représentant la transversalité). Face au problème de l'évaluation, nous suggérons à la suite de plusieurs chercheur·euses une importance de méthodes qualitatives ou mixtes pour éviter une réduction de la complexité qui limiterait l'évaluation de l'esprit critique ou de pratiques éducatives à des sous-ensembles de compétences dont la mesure serait plus facile.

Enfin, nous présentons dans les grandes lignes le contenu de la nouvelle ressource, et justifions notre choix de structure et de contenu. Au niveau de la structure et des éléments visuels, nous présentons chaque chapitre sur le même modèle. Un résumé des points essentiels dans un encart dédié; une présentation d'une façon d'éduquer à l'esprit critique largement répandue mais problématique; une explication des limites d'une telle approche; des suggestions d'alternatives inspirées de recherches; une liste de questions réflexives à la fin du chapitre pour consolider les apprentissages liés à la lecture de la nouvelle ressource; une synthèse visuelle du contenu du chapitre. De plus, au fil du chapitre, les concepts et termes clés sont définis dans un encart spécifique, et des exemples concrets sont proposés à travers des hyperliens renvoyant aux défis et actions du réseau dédié à l'éducation à l'esprit critique. Après une section dédiée à la définition des approches critiques, les quatre grands chapitres qui composent la nouvelle ressource que nous résumons dans l'article sont les suivants : un chapitre dédié aux rapports aux savoirs, incluant des travaux reliés aux croyances épistémiques à la nature des sciences; un chapitre dédié à la métacognition et la réflexivité, deux concepts invitant à un retour réflexif sur sa propre pensée et sur le contexte socio-économico-politique; un chapitre dédié à l'argumentation, autour de

questions socio-scientifiques notamment, proposant plusieurs paradigmes comme l'argumentation dialogique, l'argumentation intégrative critique, ou la philosophie pour enfants et adolescent·es ; un chapitre dédié à l'évaluation de l'information, en particulier de la crédibilité des sources mais aussi du rôle essentiel des émotions.

Finalement, l'ensemble de cette thèse a mobilisé de nombreux cadres théoriques, d'une part lié à l'utilisation par des enseignant·es de recherches en éducation, d'autre part sur l'éducation à l'esprit critique. À travers une multitude d'approches méthodologiques différentes, nous avons contribué à faire avancer ces deux champs de recherche. D'une part, nous avons dans chacun des champs montré

d'importantes limites théoriques ainsi qu'un manque de clarté dans certaines recherches, et d'autre part nous avons proposé des alternatives ou des améliorations s'appuyant sur des travaux de recherche récents. La plupart des articles inclus dans cette thèse s'appuient sur un travail collaboratif qui aura mobilisé autant des chercheur·euses que des enseignant·es. Ce travail pourra avoir des implications sur la facilitation de l'utilisation par des enseignant·es de recherches sur l'éducation à l'esprit critique. Pour des chercheur·euses, cette thèse ouvre la voie à une façon d'envisager et d'organiser des collaborations dont les concepts-clés seront mieux documentés, et le processus transparent. Cette thèse ouvre également la voie à de nouvelles façons d'étudier l'éducation à l'esprit critique sous le prisme des approches critiques, notamment à l'échelle d'un groupe. Pour des formateur·rices sur ces thématiques, cette thèse propose une ressource et un réseau qui peuvent servir de base solide en lien avec des recherches. Enfin, pour des enseignant·es, cette thèse offre une ressource sur l'éducation à l'esprit critique qui vient répondre à un manque, et qui, nous l'espérons, sera agréable à lire. Cette thèse propose également des pistes pour s'ouvrir à des collaborations avec des chercheur·euses. Finalement, cette thèse est politique et s'adresse à des décideur·euses : la meilleure chance pour des recherches collaboratives d'atteindre les objectifs co-définis avec toutes les parties prenantes, c'est lorsqu'un travail est fait au niveau du système et des structures, bref, allouer les moyens nécessaires pour soutenir et étendre de telles collaborations à l'avenir.

Acknowledgments

I was extremely lucky to have two supervisors who completed each other perfectly in terms of the knowledge and skills needed to support me well, but above all, who were the best human beings to make this journey with. More than supervisors: inspiring mentors, lovely colleagues, critical friends. Thank you so much for your dedication, Philippe and Ignacio. Likewise, I am grateful for all my jury members who read my work and dedicated time to make me grow as a researcher.

I am also grateful for all of you, wonderful people, who took part in my PhD life one way or another. The core *Profs-Chercheurs* team, Murillo, Carole and Grégory first, then Manon, Marine, Hélène and Gaby, the DevC team, and all others. The ÉPhiScience team, especially Lisette for all the support, friendship, and projects shared, but also Rémi, Méli, Camillou – BRAVOOO! –, Pauline, Azurin, Laetitia, Eleonora, Audrey, and all others. ÉPhiScience is not dead, it's just the beginning!

I am incredibly proud and happy to have been able to work with so many inspiring teachers and researchers throughout this PhD. I hope this is just the beginning, but I already want to thank you for all the time and trust you invested in me: Nathan, Jacques and Thomas of course, and amazing teachers such as Christophe, Alphonse, Charlie, Juliette, Elodie, Karine, Philippe, Céline, Aline, Adeline, Stéphanie, Nicolas, Nicolas, Maxime, Laurence, Arnaud, Maryline, Guillaume, Denis, Adeline, Fanny, Florian, Anna, Magali, Geraldine, Nadia, Corinne, Romain… and amazing researchers such as Charlotte – we have done so many things in common that I feel this is also party your PhD –, Mathieu, Gwen, Kévin, Gilles, Céline, Virginie, Sabine, Véronique, Albert, Marc-André, François, Antonin, Erik. If I forgot someone, I owe you cookies. My thanks also goes to Guillaume and Siddharth, may all teachers be grateful as well, but also Nathalie, Camille, Elodie, and all the admin team from LPI. I'm also grateful for the LaRAC members who welcomed me and gradually became friends (coucou Irène et al. !), and those who will soon be my colleagues!

Many thanks to all my friends, especially Léa, Esther & JF, Nanou, Clochelle & Phil, Sylvie & Nath for your patience, El', Wil', PL & Anaeli, Hugo, Victor for making me a better person, Sebounet and all friends from Café des Sciences, Noelie, Marvin, Lenaig, Marion, Alex, Augustin, Marina, Aurèle, Hugo, Maho, Thibaut, Léane, Guillaume, and so many more. You're the warm sunset after a long winter. If I forgot you, this time you're the ones owing me cookies.

I also want to thank my amazing flatmate, Laura, and my extended family: Jean-Pierre & Laurence, for their precious ongoing support on so many occasions, but also my parents and grand-parents, for their love and care, even when we're not physically together.

Elise, you showed me the way, you held my hand when I was afraid, and you made our adventures memorable. I can't wait for what comes next.

If one page is not enough to thank everybody who deserves it, this shows my work has never been solitary during those four years. Lastly, I want to dedicate this dissertation to all devoted teachers who fight for social justice. I'm with you.

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Chapter 0: Introduction

We all make a large number of decisions based on our worldview – often implicit understanding of how things work, influenced by our social and cultural contexts – as well as our previous experiences – empirical evidence of how things should work in certain situations. Research is supposedly a more elaborate way to get to understand the world via a large variety of tools, methods and processes. As researchers, we build theories based on both philosophical and theoretical arguments as well as empirical probing of the world around us, building on previous work done, sometimes reaching paradigm shifts. However, as human beings embedded in a society, we are influenced by our culture and values, and our research depends on funding and policies.

The complexity of the educational contexts in which we work makes it difficult to reach consensus about theories and models to explain complex phenomena. Notwithstanding, we often hear discourses about research making 'progress', as if it was a linear, straightforward avenue to building 'better' knowledge. However, the 'Science™' was used to justify injustices: racism has long been justified by 'scientific' psychology (Winston, 2020). Research is not neutral. The 'progress' made by sciences is therefore arguably not linear, and most certainly not value-free. Who gets to decide what progress means? what sciences are? what kind of research can build legitimate knowledge? All of these questions are stakes of power. We believe such decisions should remain democratically debated. The question of legitimate knowledge is especially pregnant in educational research, due to the complex learning and teaching processes studied: differences across students, teachers, schools and educational systems, as well as all possible interactions between all of these educational stakeholders is humbling. The (possibly conflicting) values of different educational stakeholders are important to consider, and the voices of many educational stakeholders should matter with regards to educational knowledge. The place educational research should have, with its variety of approaches and methods, is also debated. For instance, there have long been scholarly discussions about the importance of teachers' use of research. But which research could be useful for teachers is not consensual. Research in education can contribute to describing and understanding some educational phenomena, but it can also lead to more prescriptive theories.

The shift towards a more neoliberal political context in most countries is sometimes linked to changes in the way research is conducted (Larose, 2019), and

which research teachers are supposed to use. Despite inconsistencies between meanings of 'evidence-based' in education (Wadhwa et al., 2024), the evidence-based movement influenced several policies. It can for instance be seen with the priority given by research funders and institutions to impact evaluation according to, mostly quantitative, experimental research. Indeed, measuring the effectiveness of interventions is often seen as a priority, or a condition to public or private funding in many research calls for projects (Russell et al., 2020).

The statement that we want students to benefit the most from their school years is probably consensual. But what is meant by benefiting the most is ambiguous and depends on our values and beliefs about the educational aims. In addition, measuring the effectiveness of educational interventions means operating what Biesta calls a "complexity reduction" (2010, p. 498), which in other words means that researchers decide what is valuable and relevant (what is being measured) and exclude all other possible variables of the equation. This choice is highly political, and we argue that it is biased towards what is easy to measure, or at least easier than other variables. For instance, complex concepts such as critical thinking do not have a consensual definition and can be studied in various ways. In the past decades, research on teaching critical thinking has mostly used the evaluation of critical thinking skills as metric to assess the effectiveness of teaching practices (Ku, 2009; Rear, 2019), while leaving aside other important components of critical thinking such as critical thinking dispositions (e.g., Lai, 2011). In fact, it is certainly easier to measure critical thinking skills than measuring critical thinking dispositions.

Research policies and funding allocated for the measurement of educational interventions may be biased towards what is easier to measure. Reducing the complexity of the object of a study is not a problem in itself, and is arguably inevitable : as researchers, we always make choices in the way we ask questions and the methods we use to answer those questions. A political problem arises when this is left unquestioned, both due to political and funding pressures as well as power stakes across research fields. I believe that as researchers, we have an ethical duty to keep in mind the consequences of choices we make about research projects we conduct. These consequences are even more important in the research about teachers' use of research, which is the main focus of my PhD.

1. Studying teachers' use of research

Our intention to study teachers' use of research as the central concept of this PhD raises five main questions:

- What is research?
- What does using it mean?
- What is the research used for?
- Who are the producers and users of research?

1.1 Defining research

The first question has been defined by different authors of the field of teachers' use of research from different perspectives. For instance, Shaik and colleagues (2018) referred to research as "knowledge generated by researchers from the academic community" (id., p. 51) while Dagenais and colleagues (2012) differentiate "general research-based information, which is the scientific evidence found in the literature (in scientific publications, systematic reviews, etc) and local research-based information, which is produced locally and intended for local use" (id., p. 286). Wei and Huang (2022) specify that research is a "theory oriented knowledge-production activity" (id., p. 139) while Sjölund and colleagues (2022) distinguish four categories of research theories: descriptive, explanatory, predictive and normative theories.

Academic-based definitions of research are one way to answer the question of what research is. Asking teachers that question is another, which was done by Mills and colleagues (2020), as they contrasted teachers' views of research with US federal policies. Based on their literature review and empirical work, they showed that research may be blurred with other concepts such as data or evidence. Interestingly, the seminal definition of research by Stenhouse (1981) as "systematic and sustained inquiry, planned and self-critical, which is subjected to public criticism and to empirical tests where these are appropriate" could also apply to research conducted by teachers themselves (Cochran-Smith & Lytle, 2015). Like Stenhouse (1981) who distinguishes research in education from research on education, Anwaruddin (2016) further distinguishes knowledge for, in, and of educational practice. While the philosophical work of conceptualizing research is beyond the scope of this PhD, we have kept an open mind about what counts as

research, while acknowledging the blurriness and contested status of multiple definitions in the field of teachers' use of research.

1.2 Defining teachers' use of research

Likewise, defining teachers' use of research is contested (Rycroft-Smith, 2022). The most frequent reference is the distinction between *instrumental*, *conceptual* and *symbolic* use of research (Weiss & Bucuvalas, 1980). Instrumental use of research corresponds to decision-making or problem-solving directly informed by research; conceptual use of research corresponds to changing one's ideas or reflection on a topic after engaging with research; symbolic use of research corresponds to the justification backed by research of decisions and actions already taken. Doucet (2019), focusing on power relationships within the field of teachers' use of research, improved this framework by adding *imposed* and *process* use of research. Imposed use corresponds to top-down, forced actions with research used as an authority (e.g., evidence-based policies forcing teachers to apply specific practices, with the alternative to be paid less) and process use corresponds to learnings about research methods when engaging in research, which is arguably empowering and thus diametrically opposed to imposed use. Other conceptions of teachers' use of research were suggested, for instance Cain and colleagues (2019) suggested three ways in which research can influence teaching practice :

"- It can inform *bounded decision-making* by providing evidence that is understood in the light of assumptions and brought into discussion from which decisions and actions emerge

- It can inform *teachers' reflection*, influencing both what teachers think about and how they think, leading to changes in their 'professional self'

- It can inform *organizational learning* when it is brought into professional conversations, both formal and informal" (id., p. 12)

The three categories of this model overlap, as do those from Doucet's (2019) model, but both models can nonetheless provide interesting insights about which aspects of teachers' practice can be informed by research.

Another important conceptualization is that of Farley-Ripple and colleagues' (2018), who framed teachers' use of research in the broader context of gaps in assumptions between teachers and researchers, associated with the depth of use and production of research. As such, teachers' use and researchers' production of

research – and vice versa – are connected as “two-way streets of engagement” (Tseng, 2017, p. 3). This horizontal approach has increasingly replaced a top-down vision of research dissemination (Erkan, 2021) which was not only problematic but also ineffective: simply sharing high quality research with teachers does not make them use it (Gorard et al., 2020). Instead, involving teachers as part of collaborative co-production of research has been increasingly seen by researchers in the field of teachers’ use of research as promising, for instance through frameworks such as research-practice partnerships (e.g., Sjölund et al., 2022).

Another inspiring work is the one from Rickinson and colleagues (2020, 2022) with a specific framework to characterize the quality of the use of research evidence. Instead of focusing on the quality of research, they explored what would count as *quality use* of research, and their framework suggests multiple determinants across a few dimensions. Beyond individuals’ and research attributes, they suggest the important role of enabling components at the organizational level (leadership, culture and infrastructure) as well as system level influences. Therefore, teachers’ use of research can be seen in a broader social and political context. In the current context, many researchers suggest that a main barrier for teachers’ use of research is the lack of time (Anwaruddin, 2016; Cain; 2016; Dagenais et al., 2012; Gentaz & Richard, 2022; Goffin et al., 2022; Hemsley-Brown & Sharp, 2003; Jones et al., 2022; Penuel et al., 2020; Pereira & Fang, 2022; Sjölund et al., 2022). Allocating time so that teachers can participate in the use and production of research therefore stresses the political dimension of teachers’ use of research.

We situate our work in relation to the critical approaches that are increasingly advocated for in the field of teachers’ use of research (Doucet, 2019; Tseng, 2022). From the understanding that the context of research production influences the type of research produced, I asked myself about the conditions to produce research which could be beneficial for teachers and their students throughout my PhD. However, studying teachers’ use of research is not of direct relevance for teachers. It may have indirect effects, but this remains very abstract from what they teach daily. In theory, research on teachers’ use of research could apply to any educational theme or discipline. As part of my PhD, I have focused on teaching critical thinking.

2. Facilitating teachers' use of research on teaching critical thinking

In most countries, teachers are supposed to teach critical thinking (Dominguez et al., 2018), but they rarely have a deep understanding of the concept of critical thinking or how to teach it (Yuan & Liao, 2023). Developing students' critical thinking is overall widely acknowledged as of primordial importance both from teachers themselves (De Checchi et al., 2023; Munkebye & Gericke, 2022) and from international institutions (UNESCO, 2016; Vincent-Lancrin et al., 2020).

The definition of critical thinking among researchers is far from consensual, even though many researchers agree that critical thinking is composed of knowledge, skills and dispositions (Lai, 2011; Rear, 2019). While Ennis' (1991) definition of critical thinking as "reasonable reflective thinking focused on deciding what to believe or do" (id., p. 32) remains vague, this definition is the most accepted. Unfortunately, it is not operational, that is, it does not lead to concrete recommendations for teachers. More recently, researchers such as Pasquinelli and colleagues (2021) have achieved the opposite: suggesting a more operational critical thinking definition as "the capacity of assessing the epistemic quality of available information and—as a consequence of this assessment—of calibrating one's confidence in order to act upon such information" (id., p. 169). Unfortunately, such a definition restricts teaching critical thinking to developing students' epistemic evaluation of information and metacognitive skills, which is far from consensual. We do not claim that critical thinking should not integrate information evaluation of metacognition – we acknowledge its importance – but rather than doing so is another example of Biesta's "complexity reduction" (2010, p. 498). The idea that critical thinking skills are narrowed to the capacity to solely assess the epistemic value of information (whether information is true or false, or plausible) hides the importance of ethical and political considerations when assessing information (Gagnon, 2020).

Other researchers have instead suggested the work on socio-scientific issues as a promising way to develop students' critical thinking while integrating ethical and political dimensions (Abrami et al., 2015; Bächtold et al., 2023; De Checchi et al., 2023). In the context of facilitating teachers' use of research on teaching critical thinking, the variety of approaches to teaching critical thinking raises an important issue: which research should be used by teachers, and for what goals?

3. Framing the problem

In the previous paragraphs, I have described the contested definitions of research, research use, and critical thinking. Therefore, there is a crucial need for ingeniosity and transparency while studying teachers' use of research on teaching critical thinking. A review of methods used to study the use of research (Gitomer & Crouse, 2019) showed several possible data collection and study design methods, and encouraged the use of mixed methods and more critical approaches in this field. We have also discussed the importance of two-way frameworks between research and teaching instead of top-down approaches to teachers' use of research. In the context of teaching critical thinking, facilitating teachers' use of research on the topic could therefore benefit from two mechanisms.

First, using research methods in a way that teachers' and researchers' voices are equally considered in designing ways to facilitate teachers' use of research on teaching critical thinking. This can be done with the inclusion of teachers in several steps of research processes, such as the co-construction of surveys and other data collection tools to the co-creation of teaching critical thinking resources.

Second, reducing the gap between teachers and researchers (e.g., Farley-Ripple et al., 2018) by inviting teachers to produce research on their practices by themselves (Cochran-Smith & Lytle, 2015). As my PhD took place within a larger programme in which such a framework was developed (Atal et al., 2022), I contributed as much to the development of this framework as this framework contributed to the outcomes of my research.

4. Aims and research questions

My work is situated where teachers and researchers intersect. As such, I can identify two main aims. On the one hand, my aim is to facilitate teachers' use of research on teaching critical thinking, not in a top-down approach but rather a critical, empowering approach, placing teachers at the same level as researchers. On the other hand, my aim is to contribute to the theory underpinning teachers' use of research within a complex case study of teaching critical thinking, especially with a critical approach to teachers and researchers' roles.

Therefore my two related research questions are:

- How can collaborative approaches contribute to the facilitation of teachers' use of research on teaching critical thinking?

- How can we reconceptualize teachers' use of research and teaching critical thinking in an empowering and emancipatory way?

5. Organization of my dissertation

My dissertation is composed of five articles (the first one published in a peer-reviewed journal, the other four currently in preparation for submission).

In the **first article**, I report a study on teachers' use of research by inquiring on what different educational stakeholders, mainly teachers and researchers, think about the factors facilitating teachers' use of research. I have used Weiss and Bucuvalas' (1980) categories of research use as a reference, and included specifically the instrumental and conceptual use of research. In order to avoid producing myself research which would conclude about what teachers should do or change, I focused instead on factors influencing teachers' use of research that either researchers or educational decision makers could act on (e.g., writing research appropriate for an audience of teachers, or giving institutional support for teachers' use of research). I thus left aside teacher characteristics influencing their use of research, even though they play a role (Dagenais et al., 2012). Because of methodological constraints, my empirical study relied on an implicit vision of what research is. I surveyed 440 participants about a virtual situation in which teachers had accessed research on a topic they were interested in. The angle I chose was meant to understand to what extent the roles of educational stakeholders play a role in their perceptions of teachers' use of research. In other words, I wanted to know if teachers and other stakeholders had the same understanding of the problem and possible solutions, or if there was a need to bridge the gap between these different professionals as to what should be the priority to help teachers use research.

In the **second article**, I report a study on teachers' use of research through a systematic review of published reviews in the field of teachers' use of research, evidence, data and knowledge. As we illustrated in the introduction, the concepts of 'research' or its use are widely debated (Rycroft-Smith, 2022). The fact that teachers may interpret research as similar to data or evidence (Mills et al., 2020) suggested that by restricting our systematic review to research, as defined by researchers, we would miss interesting frameworks. We grouped the concepts of research, evidence, data and knowledge to be used by teachers into an acronym: REDaK. My systematic review was a way to explore the differences and similarities across these research fields on four levels. The first level was related to the

definition of the concept of REDaK; the second level was related to the definition of the use of REDaK; the third level was related to the educational goals for which teachers' use of REDaK was suggested; the fourth level was related to the underlying vision of teachers' and researchers roles as well as more systemic elements (Rickinson et al., 2022). Finally, I used that work to connect these four levels, trying to understand and frame the possible connections between researchers' vision of REDaK, teachers' use of REDaK, educational goals and educational stakeholders' roles. This finally led me to suggestions about connecting teachers' use and production of research (Farley-Ripple et al., 2018).

These first two articles already contributed to answering the question about the reconceptualization of teachers' use of research. But the other three articles were grounded in a specific case study about facilitating teachers' use of research on teaching critical thinking.

In the **third article**, I report a study on the process and result of a collaborative design-based research project (Sanchez & Monod-Ansaldi, 2015) aiming at including teachers and researchers to collaboratively produce a research-based resource on teaching critical thinking. Design-based research was judged as adapted for the context of this project because it includes both contributing to producing original research while helping solve practical teaching problems, and because it is highly collaborative. In addition to the resource creation, our design-based research project aimed at linking the resource with a teacher-research network (Atal et al., 2022) dedicated to teaching critical thinking. The process included multiple steps in which different teachers and researchers could participate, and the result could set the ground to create teacher training.

In the **fourth article** I report a study on the analysis of teachers' and researchers' motivations for engaging in collaborative research. We have used a survey, inspired by the work of Thi My (2018), which was both used as a research tool but also a way to organize the next step for our design-based research project. The survey contributed to focus not only in the study of general, abstract motivations by teachers and researchers, but rather to document motivations about specific stages of our design-based research project. This contributed to what Sanchez and colleagues' (2017) reported as missing: the detailed understanding of the unfolding of a design-based research project. While exploratory in nature, this article contributed to the first two articles' attempts to question the roles of teachers and

researchers, and the extent to which a ‘two-communities’ framework makes sense (Caplan, 1979; Crain-Dorough & Elder, 2021; Sjölund et al., 2023; Taylor et al., 2023).

In the **fifth article** I report a theoretical argumentation for the introduction of the conceptual framework of teaching critical approaches for students’ transversal mobilization as a replacement for the well established concept of teaching critical thinking. This conceptual framework related to teaching critical thinking is one of the outcomes of our design-based research project described in the third article, and is central in our resource aiming at facilitating teachers’ use of research on teaching critical thinking (appendix 12). We have first analyzed recurrent limitations and problems in the field of teaching critical thinking, before suggesting how teaching critical approaches and the way we operationalize it contributes to overcoming various acknowledged pitfalls. This article gives researchers the rationale for our new conceptualization, as opposed to the resource which was aimed at a target audience of teachers.

The global conclusion addresses the extent to which my work through all five articles could answer the two main research questions outlined above, as well as achieve the related aims. We end this dissertation with research perspectives that were perceived as promising after the completion of this work.

Chapter 1: Six factors facilitating teachers' use of research. An experimental factorial survey of educational stakeholders perspectives

This article was published in Frontiers in Education on May, 17th, 2024:
https://doi.org/10.3389/feduc.2024.1368565

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Keywords: Use of research, Evidence-based education, Factorial survey, Teachers, Research-practice partnerships

Supplementary information and preregistration is available here:
https://osf.io/xc948/

Conflict of interest

Nothing to declare.

Acknowledgements
We would like to thank Murillo Pagnotta for his advice at an early stage of this project, Liliane Portelance and Kristine Balslev for their helpful comments, Thomas Canva for his time and help with some parts of the code in R. We are grateful towards Éric, Dominique, Audrey, Nicolas and Florence who participated in the reduction and definition of the factors used in this study, and we appreciate the time taken by all the respondents of the survey. Huge thanks to Salomé Cojean for her useful comments on this manuscript.

Author contributions

The following table summarizes the contributions of each author according to the relevant elements of CRediT taxonomy.

	NJ	JJ	IA	PD
Conceptualization	x		x	x
Data curation	x	x	x	
Formal analysis	x	x	x	
Investigation	x			
Methodology	x	x	x	x
Project administration	x		x	x
Supervision		x	x	x
Validation	x			
Visualization	x		x	
Original draft	x			
Review & editing	x	x	x	x

Ethical committee approval

This study was approved by Inserm's Institutional Review Board (IRB00003888).

Funding

This research was partly funded from a doctoral grant attributed to the main author (Université Paris Cité, ED 474 FIRE) and funding from Bettencourt Schueller Foundation as part of a larger research project entitled Teachers as Researchers, led by Dr Ignacio Atal. The funders had no involvement whatsoever in any step leading to the writing of this manuscript.

Abstract

Teachers' use of research has been increasingly advocated for in the past few decades, and some research has documented the factors which positively or negatively influence teachers' use of research. However, the existing research doesn't give relevant information to prioritize between different ways to facilitate teachers' use of research. In addition, different professionals working in education may have divergent opinions about such priorities. This study therefore asks what are the factors that most influence teachers' use of research according to teachers, teacher trainers, educational decision makers and researchers? We conducted a factorial survey experiment on six factors with 100 participants (pilot study) and 340 participants (main study) to identify which factors were perceived as influencing the most teachers' use of research and to compare respondents' perceptions according to their main role in education. This study shows that support for research use by the institution and instrumental utility of research are the factors that were judged as most impactful. Some categories of respondents had conflicting views about specific factors, for instance researchers perceiving teachers' involvement in research as less likely to facilitate teachers' use of research. These findings can help decision-makers and teacher-trainers with limited resources to allocate them in a more effective way, while taking into consideration the disagreements across professions in order to resolve possibly arising conflicts.

In recent decades, educational policies have pushed to ground the teaching profession in research (Basckin et al., 2021) in many countries, including France (Lima & Tual, 2022) and the US (Joyce & Cartwright, 2020). In parallel, researchers have increasingly studied teachers' use of educational research and have shown a clear gap between educational research and teachers' practice: despite institutional pressure, teachers rarely rely on research as a primary source of knowledge to inform their practice (Borg, 2010; Carnine, 1997). Teachers' use of research has been explored using terms such as evidence-based education or practice (Dachet & Baye, 2020; Biesta, 2010), use of research-based information (Dagenais et al., 2012) and use of research evidence (Tatto, 2020). Terms that refer to promising ways to improve teachers' use of research include research-practice partnerships or knowledge brokering (Anwaruddin, 2016; Rycroft-Smith, 2022, Wentworth et al., 2023). This diversity of research and terminology makes it difficult to gain a broad understanding of the field, and some authors have highlighted the need to clarify what we mean by 'research' or 'use' (Rycroft-Smith, 2022). For example, Penuel and colleagues (2016) used Weiss and Bucuvalas' (1980) conceptualization, in which the use of research can be conceptual (changing one's ideas about a problem), instrumental (changing one's practices), or symbolic (justifying an action taken). A more complex model adds 'imposed use' which is "use mandated by government initiatives to promote evidence-based programs and practices" (Doucet, p. 1) and 'process use', or "the learnings gleaned by practitioners when they engage in research production" (id.). Cain and colleagues (2019) sought to model more precisely the ways in which research can inform educational practice:

"- It can inform bounded decision-making by providing evidence that is understood in the light of assumptions and brought into discussion from which decisions and actions emerge

- It can inform teachers' reflection, influencing both what teachers think about and how they think, leading to changes in their 'professional self'

- It can inform organizational learning when it is brought into professional conversations, both formal and informal." (ibid., p. 12)

Referring to Weiss and Bucuvalas' conceptual-instrumental-symbolic widely used model (Finnigan, 2021; Gitomer & Crouse, 2019), many authors have criticized an overemphasis on the instrumental use of research (Cain et al., 2019; Rycroft-Smith,

2022), while the conceptual use of research is often undervalued (Farrell & Coburn, 2016). One reason for this may be the difficulty for researchers in capturing teacher change related to conceptual use of research, which may be more long-term and less amenable to measurement or observation. However, the distinction may still be useful, as various studies highlight that many teachers want clear, practical activities inspired by research that they can adapt quickly (Drill et al., 2013; Joram et al., 2020), while deep conceptual use of research may take longer, although it is arguably more important.

Farrell and Coburn (2016) identify various ways in which conceptual use can occur, such as “introduce new concepts”, “broaden or narrow understandings about the kinds of solutions [that] should be considered and [that] are most appropriate to pursue” or to “provid[ing] a framework to guide action”, but we still need more comprehensive models of teachers’ use of research.

Dagenais and colleagues (2012) conducted a literature review in which they listed 32 factors that play a role in teachers’ use of research. This list was divided into four sections including factors related to the characteristics of practitioners (10), research (5), communication (7) and schools (10). Table 1 extracts for each category two examples of factors listed by Dagenais and colleagues (2012).

Table 1.

Examples for each category of factors influencing teachers’ use of research (Dagenais et al., 2012, p. 297-299).

Category	Example of factors
Characteristics of research	Connected to school/classroom context
	Relevant
Characteristics of communication	Access to research and data
	Collaboration with researchers
Characteristics of practitioners	Prior participation in research
	Involvement in research
Characteristics of schools	Staff capacity and support to use research
	Allocates time and resources, including available technology

On closer examination, some factors appear to overlap (e.g. Prior participation in research and Involvement in research), and most lack an explicit and detailed definition (e.g. Access to research and data). This leaves the understanding of these factors open to interpretation (e.g. what counts as relevant, according to whom and on the basis of what criteria). This ambiguity of terms raises similar problems to the lack of a clear definition of 'research' or its use described earlier. Authors such as Rycroft-Smith (2022) argue that progress in supporting teachers' use of research could be achieved with greater conceptual clarity. Studying factors that influence (positively or negatively) teachers' use of research may help us to clarify the concepts and better support teachers willing to use research.

Many authors report that teachers lack time and institutional support to use research (e.g. Anwaruddin, 2016; Borg, 2010). It is therefore of interest to consider specifically how professionals who support teachers (e.g., researchers, teacher educators, or decision makers) could better support them to use research, rather than leaving the burden on teachers. Such a focus would lead us to set aside Dagenais' factors related to the characteristics of practitioners and to emphasize the relevance of factors that these professionals can act on (e.g. researchers can act on the characteristics of research, trainers on communication, and decision makers on schools). Narrowing the focus to a few carefully selected factors could help to conduct empirical research on effective ways to support teachers' use of research.

While Dagenais and colleagues (2012) contribute by providing a broad account of the factors that influence teachers' use of research, some work is still needed to understand which factors should be considered first in order to best support teachers' use of research.

Among efforts to facilitate teachers' use of research, much work has been devoted to disseminating research findings (Anwaruddin, 2016) in a top-down, linear and unidirectional manner. Unfortunately, such an approach may not only be ineffective but also problematic (Rycroft-Smith, 2022): it disempowers teachers (Dupriez & Cattonar, 2018), who are seen as mere technicians applying things designed by researchers (Biesta, 2010). The example of the Education Endowment Foundation's Literacy Octopus project (2019), a large-scale research project in the UK investigating different ways of communicating research on literacy teaching and learning to schools, illustrates well the ineffectiveness of dissemination. Indeed, the project's partners used research summaries, evidence-based practice guides,

webinars, face-to-face continuous professional development events and online tools without any significant effect on teachers' practice.

Beyond dissemination, according to Gorard et al. (2020), promising approaches include ongoing, iterative approaches, such as coaching with personalized feedback, or collaborations with researchers to involve practitioners who are doing research themselves. Having research champions or leaders within a school who are familiar with research on a topic can also help teachers engage more with that research. But as the authors put it "We need better studies of evidence-into-use in education [...] There are currently too few, and the overall picture is unclear." (ibid., p. 29)

The professional judgment of teachers, researchers, teacher educators and decision makers may also be used to prioritize the actions we can take to facilitate teachers' use of research. On the one hand, these education professionals are arguably in the best position to help teachers, and on the other hand, any divergent perspectives could be informative for improving the collaborations needed for teachers' use of research. For example, it may be very important for teachers to be involved in the research process and to have clear guidance on how to translate research findings into concrete practice while researchers may overlook it. If researchers believe that teachers should not contribute to producing research because this would reduce its quality, these conflicting views need to be resolved in order to move forward. If they cannot, then teachers are faced with a 'blizzard of advice' (Bryk, 2015, p. 471) that makes their decisions unmanageable.

Thus, comparing the perspectives of teachers and other educational stakeholders may shed light on the divergent views that need to be resolved in order to effectively support teachers to use research.

Our study aims to understand how different stakeholders perceive the influence of different factors on teachers' use of research. We will focus on a limited number of factors that researchers, teacher trainers or decision makers can act on to support overburdened teachers. As we have already mentioned, promising factors might relate to time and support for teachers' use of research, collaboration between teachers and researchers, or different ways in which research information could be effectively communicated to support different uses of research by teachers.

The research questions guiding this work are:

- According to different educational stakeholders, what are the factors that most influence teachers' use of research?
- What are the differences in the judgements of educational stakeholders according to their role?

2. Methods

We first chose factors influencing teachers' use of research and included them in vignettes (short descriptions of a fictional situation) rated in a survey by participants based on the likelihood that the fictional teachers would use research of interest to them. We conducted a pilot study with the first responses to the survey to generate specific hypotheses and estimate the sample size required to test them. We then tested the hypotheses in our main study and explored other findings with the responses of all the other participants.

We will first describe the experimental factorial survey method that we used. We will then describe the process of selecting the factors included in this study, the construction of the survey and its administration, and the data analysis.

2.1 Factorial Surveys

Our study consisted of an experimental factorial survey (Hox et al., 1991; Wallander, 2009), also known as experimental vignette design (Aguinis & Bradley, 2014; Atzmüller & Steiner, 2010). This research method helps to understand participants' beliefs or judgments (Auspurg & Hinz, 2015) by using vignettes that participants can judge according to specific questions. In most experimental vignette-based designs, many vignettes are systematically generated and each participant is asked to judge several vignettes. The responses of multiple participants to different vignettes are then analyzed to identify elements of the situation (or characteristics of the participants) that influence their responses. This method has been widely used to judge the fairness of household incomes based on situations in which socio-demographic characteristics such as gender, schooling, and years of professional experience vary (Auspurg & Hinz, 2015).

Factorial surveys have also been used in education (e.g., Geven et al., 2021 on teachers' expectations of students). In our context, we used such a method to assess the relative weight of different factors influencing teachers' use of research as perceived by various educational stakeholders. As vignette evaluation is useful for testing the influence of the participant's role in the evaluation of the vignette (Gutfleisch, 2021), we used this method to assess the difference in perception

between different educational stakeholders regarding the factors influencing teachers' use of research.

2.2 Choice of the Factors Influencing Teachers' Use of Research

The methodological recommendation for factorial surveys is to have (7±2) factors with a low number of levels (2 or 3) (Auspurg & Hinz, 2015, p. 48). This is to avoid having too large a vignette universe (defined as the product of the levels of each factor), which would either require a larger sample size or reduce the power of the survey.

We listed the 32 factors from Dagenais and colleagues (2012) in a table and defined each of them. We then invited two teachers, two decision-makers and two researchers from our personal contacts working in France to independently produce a shorter list of 10-15 factors. Their task was to select, reformulate and possibly merge the initial factors. They were asked to provide concrete examples of situations in which each factor could play a role. The instructions and files used are available on https://osf.io/xc948/files/osfstorage.

Our team then built on this work and scientific literature to produce a short list of clearly defined factors. For example, research led us to include the time required for research use (Borg, 2010), the distinction between instrumental and conceptual use of research (Penuel et al., 2016), or collaboration between researchers and teachers (Gorard et al., 2020).

In Table 2, we present our final list of six factors influencing teachers' use of research that are external to teachers (e.g., related to characteristics of the research or teachers' institutional context), where each factor could take a negative (-) or positive (+) value. We described each level as a short sentence that was included in the vignettes shown to the participant, so that one piece of information from each factor was included in all vignettes (see example below). We described the factors so that there would be no overlap between them, and in such a way that each would refer to real-life situations in which it played a role in teachers' use of research.

Table 2.

Factors used in the factorial survey and their levels.

Factors (variable name)	Level	Vignette Text

Target audience for research (TchAudience)	-	Mx. A. accessed research on a topic of interest which was communicated in an unsuitable way to a teacher audience.
	+	Mx. A. accessed research on a topic of interest which was communicated in a suitable way to a teacher audience.
Any teacher involvement in the production of the research (TchInvolv)	-	This research was produced without teacher input.
	+	This research was produced with significant input from teachers.
Conceptual utility of the research (ConceptUtil)	-	It does not provide elements that facilitate reflection on this topic.
	+	It provides elements that facilitate reflection on this topic.
Instrumental utility of research (InstrumUtil)	-	It does not provide elements facilitating a concrete change of educational practices in relation to this topic.
	+	It provides elements facilitating a concrete change of educational practices in relation to this topic.
Collaborations for research use (CollabRes)	-	Mx. A. does not have the opportunity to collaborate with peers, researchers or other education professionals in using research.
	+	Mx. A. has the opportunity to collaborate with peers, researchers or other education professionals in using research.
Support for research use by the institution (SupportInst)	-	The hierarchy or the institution does not put anything in place to facilitate the use of research by teachers.
	+	The hierarchy or the institution provides facilities (e.g. dedicated time, training, budget, etc.) to support the use of research by teachers.

2.3 Survey Construction

We created a survey to collect demographic information from respondents and present them with a series of vignettes. The demographic questions in our survey (see https://osf.io/xc948/files/osfstorage) included (1) years of experience in education; (2) main role held in the past three years; (3) other(s) role(s) held in the past; (4) category-specific information (e.g. school level and subject taught for teachers; research topics for researchers; specific roles and institutions held by trainers and decision makers). We included years of experience because both the use of research and years of experience have been studied in relation to teaching quality (e.g. Graham et al., 2020; Gorard et al., 2020). We included the other variables to explore the relationship between role and teachers' judgments about teachers' use of research, which, to our knowledge, has not been done before.

We categorized the different roles that educational stakeholders could take as (a) decision makers, (b) researchers, (c) teachers, and (d) trainers (see Table 3).

Table 3.

Description of the roles.

Role	Description of the role
Decision makers (Dec)	Individuals with any institutional, political or administrative responsibilities affecting teachers in primary or secondary education with whom they are not in direct contact (territorial or national policies, program development, development of evaluation systems, etc.).
Researchers (Res)	Educational researchers (including doing a PhD, or the years of participation in action research, etc.)
Teachers (Tch)	Teachers at primary or secondary levels.
Trainers (Tr)	Individuals doing direct supervision, training and/or coaching of teachers in primary or secondary education.

From the list of 6 factors with 2 levels, the full universe of vignettes (consisting of 2^6=64 possible combinations of the different levels) was systematically generated by selecting exactly one level per factor to create a short description. The following

is an example of a vignette and all vignettes used are in https://osf.io/xc948/files/osfstorage.

"*Mx. A. accessed research communicated in an unsuitable way to a teacher audience [TchAudience-] on a topic of interest to her. This research was produced with significant input from teachers [TchInvolv+].*

It provides elements that facilitate reflection on this topic [ConceptUtil+] and it does not provide elements facilitating a concrete change of educational practices in relation to this topic [InstrumUtil-].

Mx. A. does not have the opportunity to collaborate with peers, researchers or other education professionals in using research [CollabRes-]. The hierarchy or the institution provides facilities (e.g. dedicated time, training, budget, etc.) to support the use of research by teachers [SupportInst+]."

After each vignette, respondents were asked to rate the situation: "Given this context, how likely do you think it is that [the teacher described in the situation] will use the research that (s)he is interested in?". Participants had to answer using a slider corresponding to an 11-point Likert scale ranging from 'extremely unlikely' (-5) to 'extremely likely' (5).

To avoid respondent fatigue, it is recommended not to present more than 10 vignettes to each participant (Auspurg & Hinz, 2015). Furthermore, reducing the total number of vignettes reduces the number of participants required for the study. In order to reduce the number of vignettes in a study after choosing the factors and levels, the authors (ibid) recommend using a D-efficient sample of the vignette universe instead of a random sample. A D-efficient sample is an optimal way to balance the number of occurrences of each level, thus gaining power for the analysis without losing too much information. The D value is an index representing the extent to which the sample is balanced, and the closer to 100 that value is, the better. The skpr package v. 1.0.0 in R (Morgan-Wall & Khoury, 2021) allows to generate not only a D-efficient sample of a given vignette universe, but also to separate it in blocks. We therefore used it to generate an optimal D-efficient sample (D=100) of 16 out of the 64 possible vignettes with two equivalent blocks of 8 vignettes each, so that each participant will have to judge only 8 vignettes.

We used LimeSurvey software to create the survey. The survey began by informing all participants of how their data would be used for this research and of their right

to request that their data be deleted afterwards. We then asked demographic information (see https://osf.io/xc948/files/osfstorage) and then randomly assigned respondents to one of two blocks of vignettes. Within each block, the order of presentation of the vignettes was randomized (Auspurg & Hinz, 2015). Participants could stop at any time by closing the survey, and previous responses were recorded. Responses from participants who only provided demographic information, but didn't rate any vignettes, were not used.

2.3.1 Survey Administration

Respondents were recruited in France and were expected to work in a French context. We used convenience sampling, social media, researchers' networks and snowball sampling. The survey was launched on 23 June 2022 and closed after six months.

2.3.2 General Analysis Plan

We designed a fractional factorial survey experiment using multilevel modeling and a confounded factorial design. It includes both crossed (the factors influencing teachers' use of research all co-occur for each participant) and nested variables (the vignette judgments are nested under the participants and the factors are nested under the blocks) (Auspurg & Hinz, 2015). The demographic characteristics and factors are independent variables, and the participants' judgments of the vignettes is a dependent variable. This analysis plan was used for both pilot and main studies.

2.4 Pilot Study

To our knowledge, no study compared the relative weights of the factors, we had thus limited background on which to build hypotheses. We therefore used the first 100 survey responses (50 from each block) to conduct an exploratory pilot study to generate specific hypotheses and estimate the sample size required to test them.

2.4.1 Data Analysis

First, we created a full Linear Mixed-effects Model using the R package lme4 (Bates et al., 2015) including all 6 factors (TchAudience, TchInvolv, ConceptUtil, InstrumUtil, CollabRes, SupportInst) without Role and its interaction with the factors.

$$answer \sim block + TchAudience + TchInvolv + ConceptUtil + \qquad (m1)$$

InstrumUtil + CollabRes + SupportInst + (1|Part_id) + (1|Vign)

Here 'answer' corresponds to the participant's judgment of the vignette; block is either of the two blocks of 8 vignettes that the participant was assigned to; Part_id is the unique identifier of each participant, Vign is the vignette being judged; 1|Part_id and 1|Vign are the random intercepts associated with the participant and vignette respectively.

Our aim was to simplify each model as much as possible, while increasing our ability to explain the participants' responses, in order to identify which factors played a significant role. To do this, we iteratively dropped variables from (m1) and tested whether the simpler model differed from the original. To compare the models, we used likelihood ratio tests via the anova command applied to lmer model objects (Bates et al., 2015). If the two models were not significantly different, we repeated the process using the simpler model. We first tried to drop the (1|Vign) component, as the randomisation of vignettes should prevent any significant vignette random effect. We then tried to drop the non-significant interaction effects, but as all factors played a significant role, we kept the following model:

answer ~ TchAudience + TchInvolv + ConceptUtil +
InstrumUtil + CollabRes + SupportInst + (1|Part_id) *(m2)*

We then observed the relative weight of each factor with the reduced sample used for the pilot study according to the model m2. Our results showed differences worth exploring in our main study: some factors clearly seemed to be rated as influencing more teachers' use of research than others, while other factors seemed to be judged more or less equally. We used this to generate our first two hypotheses below.

Similarly, we created a full linear mixed-effects model including all 6 factors and adding their interaction with the participant's main role (Role), using the teacher role (Tch) as the reference level of all analyses.

*answer ~ block + Role*TchAudience + Role*TchInvolv + Role*ConceptUtil +*
*Role*InstrumUtil + Role*CollabRes + Role*SupportInst + (1|Part_id) +*
(1|Vign) *(m3)*

*Role*TchAudience* (likewise for the others) means that the model includes both variables TchAudience and Role, but also their interaction (*TchAudience:Role*).

We dropped non-significant interactions one by one, to reach the following model in our pilot study:

$$answer \sim TchAudience + TchInvolv + ConceptUtil + InstrumUtil + CollabRes + Role*SupportInst + (1|Part\_id) \quad (m4)$$

This means that the only statistically significant interaction between Role and the factors was related to *SupportInst* in our pilot study. We therefore generated one hypothesis regarding this difference to be tested in the main study.

2.4.2 Hypotheses

From the models (m2) and (m4) found in the pilot study, we constructed the following hypotheses, as we found no reason in the scientific literature to explore other hypotheses:

H1: Educational stakeholders judge that teachers who benefit from institutional support for research use (*SupportInst*) or who have access to research suggesting instrumental use (*InstrumUtil*) are significantly more likely to use research results than teachers who benefit from collaboration for research use (*CollabRes*). We will write it *(SupportInst ≈ InstrumUtil) > CollabRes* below.

H2: Educational stakeholders judge that teachers benefiting from collaboration for research use (*CollabRes*) are significantly more likely to use research results compared to teachers benefiting from research communicated to a teacher audience (*TchAudience*), research involving teachers in its production (*TchInvolv*), or research suggesting conceptual use (*ConceptUtil*). We will write it *CollabRes > (TchAudience ≈ TchInvolv ≈ ConceptUtil)* below.

H3: Decision makers judge faculty who benefit from institutional support for research use (*SupportInst*) as more likely to use research than other respondents. We will write it *RoleDec:SupportInst > (RoleRes:SupportInst ≈ RoleTr:SupportInst ≈ RoleTch:SupportInst)* below.

For each hypothesis, when we say ‘teachers who benefit from [a factor]’, we mean ‘compared to teachers who do not benefit from [that factor]’. For example, teachers who benefit from support for the use of research by the institution are to be compared with teachers who do not benefit from such support, all other things being equal.

2.4.3 Power Analyses and Sample Size Estimation

To estimate the number of respondents needed to test our hypotheses with a standard power of β = .80 and a confidence threshold of .05, we conducted a power analysis based on the data from the pilot study. We first used bootstrapping (Efron, 1979) in R (v. 4.1.3) to create a database containing information with similar statistical properties to the original data, but with more participants. We created bootstrapped datasets of n = 200, 300, ... , 1000 participants and used the PowerSim function from the simr library in R (Green & MacLeod, 2016) to assess the number of participants with which we could expect to reach the 80% threshold for our hypothesis.

2.5 Main Study

We discarded the data used in the pilot study and used the remaining 340 complete survey responses for the main study, which aimed to test our hypotheses. In order to test the underlying assumption that all factors are independent from each other, we tested the interaction effects among factors with the following model:

$$answer \sim TchAudience*TchInvolv*ConceptUtil* \\ InstrumUtil*CollabRes*SupportInst + (1|Part\_id) \qquad (m0)$$

In the rest of the study, we added any significant interactions between factors to our other models and tested whether this changed the conclusions. If not, these effects are reported independently in the results sections and we otherwise use the simpler model without these interactions.

2.5.1 Hypothesis Testing

To test H1 and H2 (relative importance between factors in their ability to influence vignette judgment), we fitted the following linear mixed effects model, following the same procedure as in the pilot study:

$$answer \sim TchAudience + TchInvolv + ConceptUtil + \\ InstrumUtil + CollabRes + SupportInst + (1|Part\_id) \qquad (m2)$$

We performed pairwise comparisons using the glht package in R (Bretz et al., 2010) to test, for any two factors, the null hypothesis that their coefficients are not statistically significantly different. For the first hypothesis, our pairwise comparisons focused on SupportInst, InstrumUtil and CollabRes. Based on (m2), testing H1 - (SupportInst ≈ InstrumUtil) > CollabRes - meant comparing (a)

SupportInst with InstrumUtil; (b) SupportInst with CollabRes; and (c) InstrumUtil with CollabRes. The null hypothesis would consist of having no statistically significant difference for (a), but showing that CollabRes is statistically significantly inferior in (b) and (c).

Similarly using the model m2, testing H2 - CollabRes > (TchAudience≈ TchInvolv ≈ ConceptUtil) - meant comparing (a) CollabRes with TchAudience; (b) CollabRes with TchInvolv; (c) CollabRes with ConceptUtil; (d) TchAudience with TchInvolv; (e) TchAudience with ConceptUtil; and (f) TchInvolv with ConceptUtil. To validate H2, (a), (b) and (c) would simultaneously have to show a statistically significant difference, and (d), (e) and (f) would have to show no statistically significant difference.

To test H3, we created a full linear mixed effects model as in the pilot study, starting with the full model (m3) including all interactions.

$$answer \sim block + Role*TchAudience + Role*TchInvolv + Role*ConceptUtil + Role*InstrumUtil + Role*CollabRes + Role*SupportInst + (1|Part\_id) + (1|Vign) \quad (m3)$$

We dropped one by one insignificant interaction effects between Role and the different factors according to successive likelihood ratio test comparisons using the anova command. As the interaction Role:SupportInst was not statistically significant, H3 could be rejected and we ended up using the following model for exploratory analyses:

$$answer \sim Role*TchAudience + Role*TchInvolv + Role*ConceptUtil + Role*InstrumUtil + CollabRes + SupportInst + (1|Part\_id) \quad (m5)$$

As explained in the results, no further analyses were needed to test H3.

2.5.2 Exploratory Analyses

For each factor, we first assessed the significance of the mean difference of the judgements with its negative and positive values using the emmeans package (Searle et al., 2012). For example, for the factor TchAudience, if TchAudience- and TchAudience+ are the means of the judgments with its negative and positive values respectively, we assessed whether the difference between TchAudience- and TchAudience+ was statistically significant. If so, this difference can be interpreted as the respondents' perceived weight of the factor in teachers' research use. We then computed all pairwise comparisons using the glht package in R (Bretz et al.,

2010), in addition to testing H1 and H2, in order to rank the factors based on their respective weights, grouping together factors for which the weight differences were not statistically significant.

We then carried out a second exploratory analysis with all the interaction effects between Role and the factors, a third including participants' auxiliary or previous roles (Auxiliary) for each of the four roles (RoleTch, RoleRes, RoleTr, RoleDec), and a fourth including participants' years of experience in education (yexp).

For the second exploratory analysis, we used the model (m5) that included all possibly statistically significant interaction effects between Role and the factors, therefore excluding interaction effects between Role and CollabRes or SupportInst, but keeping the interactions between Role and the four other factors.

For the third type of exploratory analysis, we conducted four similar analyses, each starting with the full model including all possible interaction effects between one of the variables RoleTch, RoleRes, RoleTr, RoleDec and the factors, and then iteratively dropping variables as before. Each of these variables could take three values: (1) Main (if the respondent reported this role as the main role they played in the last three years); (2) Auxiliary (if the respondent either played this role more than three years ago or played it in the last three years but as a minor function); (3) Never (if the respondent never played this role).

$$answer \sim RoleTch*TchAudience + RoleTch*TchInvolv + RoleTch*ConceptUtil + RoleTch*InstrumUtil + RoleTch*CollabRes + RoleTch*SupportInst + (1|Part\_id) + (1|Vign) \quad (m6a)$$

$$answer \sim RoleTr*TchAudience + RoleTr*TchInvolv + RoleTr*ConceptUtil + RoleTr*InstrumUtil + RoleTr*CollabRes + RoleTr*SupportInst + (1|Part\_id) + (1|Vign) \quad (m6b)$$

$$answer \sim RoleRes*TchAudience + RoleRes*TchInvolv + RoleRes*ConceptUtil + RoleRes*InstrumUtil + RoleRes*CollabRes + RoleRes*SupportInst + (1|Part\_id) + (1|Vign) \quad (m6c)$$

$$answer \sim RoleDec*TchAudience + RoleDec*TchInvolv + RoleDec*ConceptUtil + RoleDec*InstrumUtil + RoleDec*CollabRes + RoleDec*SupportInst + (1|Part\_id) + (1|Vign) \quad (m6d)$$

We set the significance threshold for model comparison at a conservative 0.01 to account for the multiple explorations and to try to avoid false positives.

For the fourth exploratory analysis, we started with the full model, including all possible interaction effects between yexp and the factors, and then iteratively dropped variables as before.

$$answer \sim TchAudience*yexp + TchInvolv*yexp + ConceptUtil*yexp + InstrumUtil*yexp + CollabRes*yexp + SupportInst*yexp + (1|Part\_id) + (1|Vign) \quad (m7)$$

2.6 Research Reproducibility

This study has been pre-registered on the Open Science Framework registry following analysis of the pilot study. The link to download the anonymised data, the code with detailed instructions for data analysis using R software, and all other supplementary material can be found there.

3. Results

3.1 Factors Choice

Of the six contacts invited to participate, both teachers and both decision-makers and one of the two researchers took part in this stage of the study. Each of these five participants independently suggested between 9 and 13 factors. Our research team then synthesized the work done, resulting in a list of 13 different factors. We then kept the 6 factors (Table 2) unrelated to teacher characteristics and iteratively defined through internal discussion, the wording of each factor and its levels to be used in the vignettes.

3.2 Power Analysis

800 participants were needed to also test H3 with an 80% threshold. However, we closed the survey before this sample was reached. Although it is likely that we had enough participants to test H1 and H2, we did not test the number of participants required first.

3.3 Characteristics of Survey Respondents

A total of 777 responses were collected, of which 337 were discarded because participants did not rate any of the vignettes. We then used 100 responses for the pilot study. This left a total of 340 participants for the main study. The unit of analysis in a factorial survey is the vignette, and in our case each participant could rate up to 8 vignettes, giving a total of 2720 (=8*340) possible vignette ratings, of which our participants rated a total of 2447 vignettes. On average, our participants had a total of 16 years of experience (min = 0, Q1 = 8, Q3 = 22, max = 55). Of the 340 participants in the main study, 10 participants (3%) presented their main role as a decision maker, 17 (5%) as a researcher, 271 (80%) as a teacher and 42 (12%) as a trainer. Table 4 below summarizes the distribution of respondents according to their main role in education and the number of vignettes each responded to.

Table 4.

Descriptive statistics of participants' roles in the main study.

Role	Number of respondents			Mean number (Q1-Q3) of years of experience for the main role
	Main	Auxiliary	Never	
Decision makers (Dec)	10	22	308	25 (20-30)
Researchers (Res)	17	68	255	14 (4-20)
Teachers (Tch)	271	51	18	15 (7-22)
Trainers (Tr)	42	106	192	22 (17-30)

Compared to the participants whose responses were used for the pilot study, the main study participants were more likely to be teachers and less likely to be in any other role (see Table 4bis).

Table 4bis.

Descriptive statistics of participants' roles in the pilot study.

Role	Number of respondents			Mean number (Q1-Q3) of years of experience for the main role
	Main	Auxiliary	Never	
Decision makers (Dec)	5	8	87	16 (10-22)

Researchers (Res)	14	20	66	17 (7-22)
Teachers (Tch)	57	30	13	16 (7-21)
Trainers (Tr)	24	35	41	24 (17-30)

3.4 Interactions between Factors

We simplified the model (m0) until we reached a model with only statistically significant interactions between factors (m0bis).

answer ~ TchAudience + TchInvolv + ConceptUtil +

InstrumUtil + CollabRes + SupportInst + ConceptUtil:InstrumUtil + (1|Part_id) *(m0bis)*

This model showed a significant difference between ConceptUtil and InstrumUtil which is compared to the simpler model (m2) in Table 5.

Table 5.

Comparison of ConceptUtil and InstrumUtil including the interaction effect.

Factor name	Estimate (standard error)		p value
	without interaction	with interaction	
ConceptUtil	1.02 (0.09)	1.36 (0.13)	<.0001
InstrumUtil	1.76 (0.09)	2.10 (0.13)	<.0001
ConceptUtil:InstrumUtil	NA	-0.70 (0.18)	<.0002

Including this significant interaction effect shows that ConceptUtil and InstrumUtil both appear to have larger effects, but only when only one of them has a positive value, while both at the same time create a more nuanced difference.

3.5 Hypotheses testing

We tested the hypothesis chosen after consideration of the scientific literature and our pilot study as described in the methodology section.

For the first hypothesis (H1): We found no statistically significant difference between the beta coefficients of InstrumUtil and SupportInst (p = 0.589), but there

was a statistically significant difference between the beta coefficients of InstrumUtil and CollabRes ($p < 0.001$) and of SupportInst and CollabRes ($p < 0.001$). This confirms our hypothesis H1: (SupportInst ≈ InstrumUtil) > CollabRes.

For the second hypothesis (H2): There was no statistically significant difference between the beta coefficients of TchAudience and CollabRes ($p = 0.357$), but there was a statistically significant difference between the beta coefficients of TchInvolv and CollabRes ($p = 0.003$). However, there was no statistically significant difference between the beta coefficients of ConceptUtil and CollabRes ($p = 0.217$). This result refutes our hypothesis H2: CollabRes > (TchAudience ≈ TchInvolv ≈ ConceptUtil).

For the third hypothesis (H3): The interaction effect between SupportInst and Role was removed by successive model comparisons, which was sufficient to reject H3 RoleDec:SupportInst > (RoleRes:SupportInst ≈ RoleTr:SupportInst ≈ RoleTch:SupportInst).

3.6 Exploratory Analyses

3.6.1 Factors' Weight Comparison

As Table 6 shows, pairwise comparisons of the beta coefficients for each factor revealed that each factor was judged to have an overall positive effect on teachers' use of research, although to varying degrees.

Table 6.

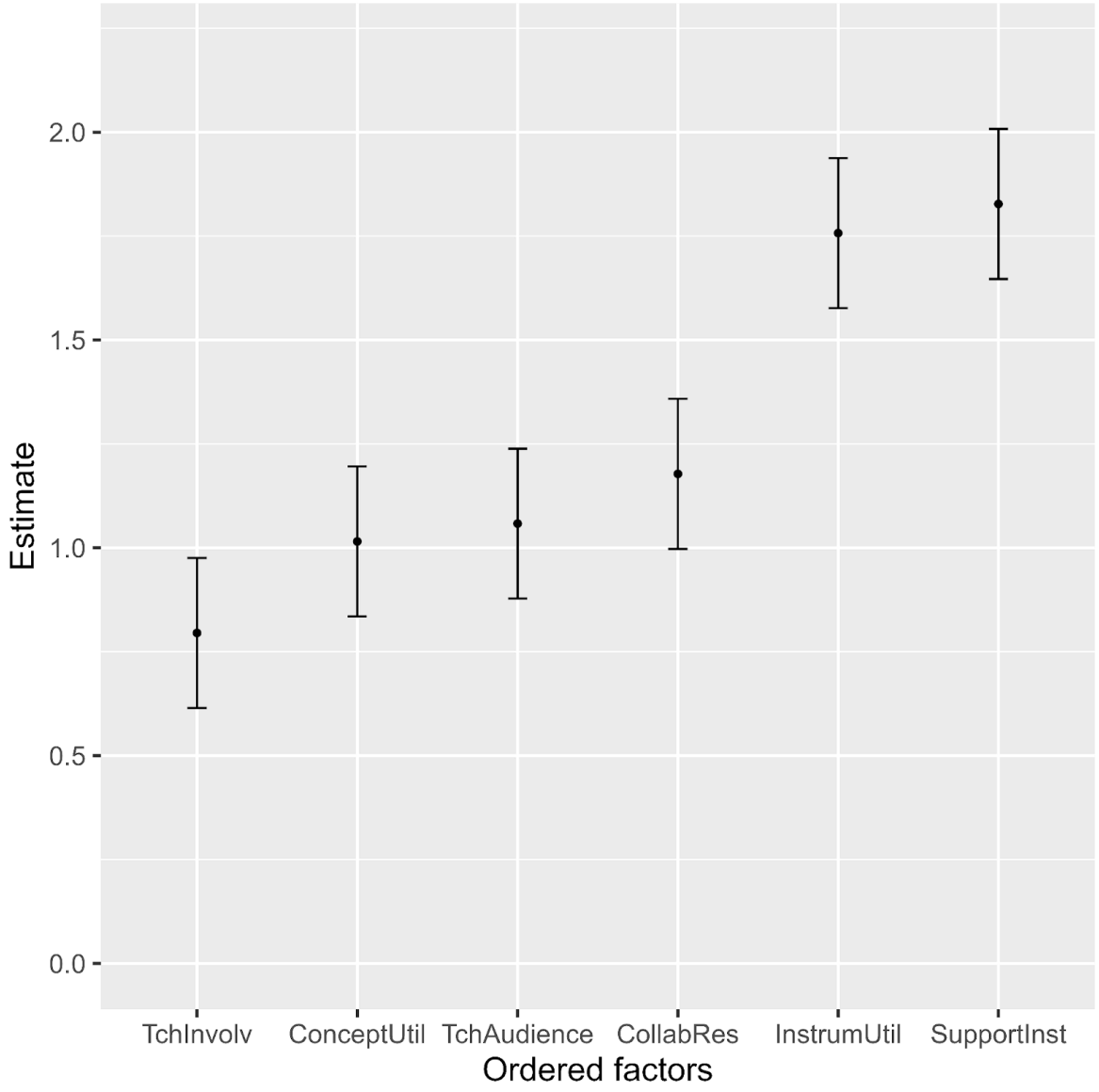
Weight estimation of each factor.

Factor name	Estimate difference	Standard error	p value
TchInvolv	.795	0.0922	<.0001
ConceptUtil	1.02	0.0922	<.0001
TchAudience	1.06	0.092	<.0001
CollabRes	1.18	0.0923	<.0001
InstrumUtil	1.76	0.0921	<.0001
SupportInst	1.83	0.0921	<.0001

Figure 1 shows a suggested hierarchy in terms of how much each of the factors affect respondents' judgments about teacher use of research.

Figure 1.

Factors ordered according to their weight.



Our pairwise comparisons (Table 6) support a clear difference between InstrumUtil and SupportInst on the one hand and the other factors on the other (which is consistent with our validation of H1). However, there is no strong significant difference between the lower rated group of four factors. The lowest rated factor, TchInvolv, does not show a statistically significant difference with the second lowest rated factor, ConceptUtil, but it does show a statistically significant difference with the third lowest rated factor, TchAudience. However, using the model including ConceptUtil:InstrumUtil, the increased weight of ConceptUtil causes it to become significantly different from the weight of TchInvolv. This

suggests that TchInvolv may weigh significantly less than other factors according to our respondents.

Table 7.

Significance of the difference between factors.

Pair of factors compared	Estimate difference	Standard error	p value
TchInvolv - ConceptUtil	0.2202	0.1307	0.092
ConceptUtil - TchAudience	0.04295	0.13173	0.744
TchInvolv - TchAudience	0.2632	0.1288	0.0411*
TchAudience - CollabRes	0.1197	0.1300	0.357
CollabRes - InstrumUtil	0.5792	0.1309	<.0001
InstrumUtil - SupportInst	0.07011	0.12994	0.589

We also looked into the interaction effect between CU and IU (Table 8).

Table 8.

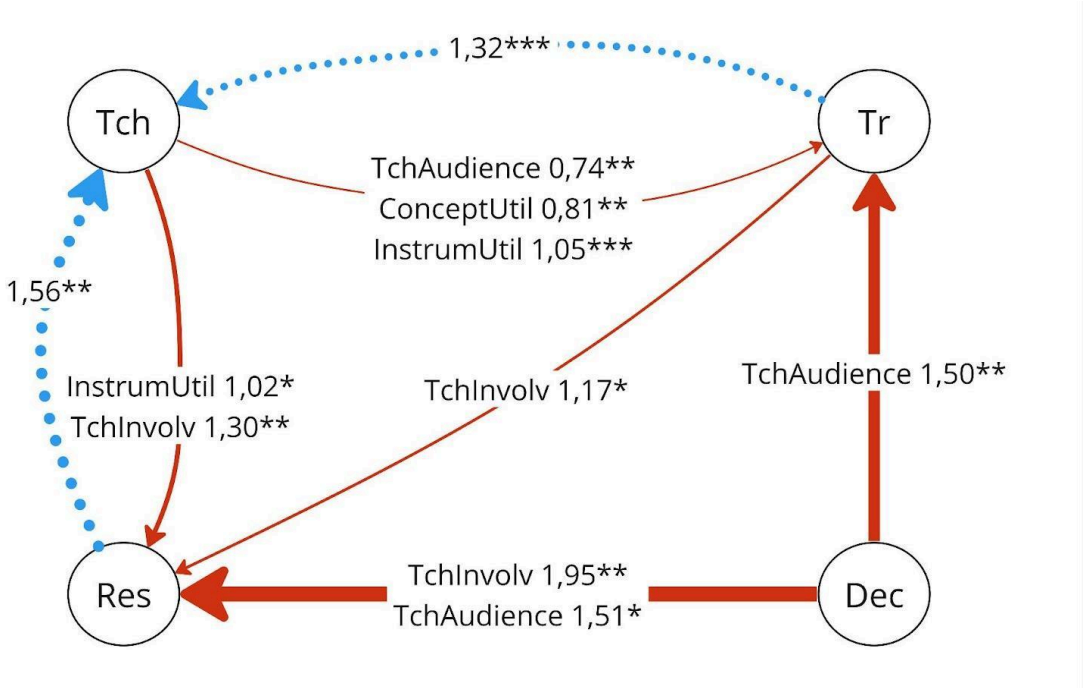
Co-variation of ConceptUtil and InstrumUtil.

Reference ConceptUtil / InstrumUtil	Comparison	Estimate difference	Standard error	p value
- / -	+ / -	1.365	0.13	<.0001
- / -	- / +	2.104	0.13	<.0001
- / -	+ / +	2.771	0.13	<.0001
+ / -	- / +	0.740	0.13	<.0001
+ / -	+ / +	1.407	0.13	<.0001
- / +	+ / +	0.667	0.13	<.0001

3.6.2 Role-Factor Interactions

Figure 2.

Summary of statistically significant differences between roles.



Each arrow represents a difference in judgment between two roles, with the role at the origin of the arrow rating higher on average than the role at the destination of the arrow. The dotted blue arrows (Tr → Tch and Res → Tch) represent the mean difference in the ratings of the vignettes, i.e. on average teachers tend to rate the vignettes significantly lower than trainers or researchers - in other words, they think it less likely that the fictional teacher shown would use the research. The full red arrows represent the difference in judgment for the named factors only. The size of the arrows reflects the relative weighting of the roles, while statistical significance is indicated by the following significance codes: '***' p<0.001, '**' p<0.01, '*' p<0.05.

3.6.3 Moderator Effects of the Auxiliary Roles

Using 'never' as a reference in both cases, the two models with RoleTch and RoleTr showed statistically significant differences in some interaction terms. The more parsimonious models m8a and m8b were derived from m6a and m6b respectively. Table 9 summarizes the statistically significant results.

*answer ~ TchAudience + TchInvolv + ConceptUtil + RoleTch*InstrumUtil + CollabRes + SupportInst + (1|Part_id)* *(m8a)*

*answer ~ RoleTr*TchAudience + RoleTr*TchInvolv + RoleTr*ConceptUtil + RoleTr*InstrumUtil + RoleTr*CollabRes + RoleTr*SupportInst + (1|Part_id) + (1|Vign)* *(m8b)*

Table 9.

Estimation of the Main-Auxiliary effects on vignettes rating.

Comparison with the value never	Estimate	Standard error	p value
RoleTchMain:InstrumUtil2	0.89778	0.41245	0.034*
RoleTrAuxiliary	0.39450	0.20271	0.052
RoleTrMain	0.57412	0.28412	0.043*
RoleTrAuxiliary:InstrumUtil2	-0.40524	0.20285	0.046*
RoleTrMain:InstrumUtil2	-1.14136	0.28580	<0.001***

3.6.4 Years of Experience in Education

Starting with a model with full interaction effects between yexp and the factors, we fitted our model by successive likelihood ratio test comparisons using the anova command and found no effect of yexp on participants' judgements. This suggests that participants' experience in education does not influence their perceptions of what influences teachers' use of research.

4. Discussion

4.1 Interpretation of Findings

We conducted a factorial survey experiment to assess the relative importance given by educational stakeholders to different factors influencing teachers' use of research. We involved teachers, decision-makers and researchers in the development of our survey and ended up focusing on 6 factors that educational researchers, trainers or decision-makers can act on. We therefore excluded teacher-related factors. The first achievement of this study is to define and operationalize the factors used, building on the work of Dagenais and colleagues (2012). Based on the responses of 340 educational stakeholders in France, our main

study shows that all the factors included in the study play a significant role in teachers' use of research, according to the participants. This is in line with previous studies that have listed similar factors as influencing teachers' use of research (e.g., Dagenais et al., 2012). In addition, our study contributed to a better understanding of the relative importance of these factors. In particular, institutional support for the use of research (Borg, 2010; Anwaruddin, 2016) and elements that facilitate the instrumental use of research (Oancea & Pring, 2008), for which decision-makers and researchers respectively may act, are considered most important. Our hypothesis testing did not allow us to identify other patterns. We will now discuss the interpretation of the exploratory analyses and suggest practical implications for both research and practice.

4.1.1 Factors Interactions

The finding that ConceptUtil and InstrumUtil interact significantly is interesting and can be interpreted in three ways.

Firstly, the way the vignettes are constructed may have caused this difference, since both factors are presented together in the same sentence: "[The research] provides elements that (do not) facilitate reflection on this topic and it (does not) provide elements that facilitate a concrete change of educational practices in relation to this topic". A clear separation of the two may qualify this interaction effect.

Secondly, participants may judge that both conceptual and instrumental use of research are important, but it is more important to predict that at least one of these two possible uses will be facilitated by the piece of research. This would explain the lower benefit of having both factors together in their positive value, compared to either of them in isolation.

Third, this interaction may be interpreted as a limitation of the Weiss and Bucuvalas (1980) model, as one could argue that the conceptual and instrumental uses of research are intertwined and strongly linked. For example, it could be argued that some kind of change in reflection (conceptual use) is necessary to lead to a change in practice (instrumental use), because if there is no reason to change, instrumental use would not occur.

Overall, this interaction does not change much the other findings of the current study.

4.1.2 Factors' Weight Comparison

The superior ratings of InstrumUtil and SupportInst should encourage future research to empirically test the extent to which they actually contribute to teachers' use of research. Due to methodological constraints, our study maintained a broad definition of instrumental utility and institutional support. We therefore believe that future research should explore which elements of these factors are the most cost-effective and scalable.

We also believe that while there is no clear hierarchy between the other factors, larger studies could help to prioritize among them. In the meantime, our study supports the idea of trying to address all of these factors simultaneously whenever possible.

4.1.3 Role-Factor Interactions

The most notable differences that might be worth exploring in further studies are first between teachers and trainers, and then between teachers and researchers. In particular, with regard to the InstrumUtil factor, which is rated higher by teachers than by trainers and researchers, it could be debated to what extent the elements that facilitate instrumental use of research by teachers actually work.

Many researchers have criticized the overemphasis on the instrumental use of research (e.g., Cain et al., 2019; Farrell & Coburn, 2016), instead emphasizing the importance of the conceptual use of research. As mentioned earlier, it is unlikely that there could be an instrumental use of research - that is, a change in practice - if there was no conceptual use at all, unless teachers were blindly applying research-based practices. Teachers are professionals (Dupriez & Cattonar, 2018; Bourdoncle, 1994) and their relationship with research is more complex, whether they use it (Cain et al., 2019) or not (Cain, 2016).

Similarly to Rycroft-Smith (2022), we believe that there is a tension in research knowledge brokering - or facilitating teachers' use of research - which she identifies as "the potential conflict between short- and long-term goals, which may also be conceptualised as the tension between impact and teacher autonomy" (id., p. 35). The idea of focusing on the instrumental use of research can be seen as a short-term perspective, and the conceptual use a long-term one. Instrumental use responds to teachers' need for something that can be implemented immediately in the classroom, while conceptual use may slowly influence the way they teach in different dimensions that may not be captured by research on instrumental use

and impact. We agree with her statement that “Knowledge brokering is not just about translating findings from research into ‘takeaways’ for practice, and there is a real danger it is seen straightforwardly as such.” (ibid). In their literature review, Heinsch, Gray and Sharland (2016) show that teachers’ use of research is seen as synonymous with evidence-based practice (Biesta, 2010).This is problematic in at least two ways. First, ‘evidence-based’ refers to a limited range of research that is then to be used in an instrumental way. Second, the focus on evidence-based research has been widely criticized, for example by Biesta (2010), who argues that what counts as evidence is always subject to interpretation and that underlying values may conflict with other values but are nonetheless important.

Further research could explore other ways of conceptualizing the different ways in which research can be used, which could then be used to better understand the discrepancy between teachers’ and other educators’ judgments about the instrumental use of research.

The other relevant interaction in our study is between the researchers and the ‘teacher involvement in research’ factor. Although not statistically significant, the only case where respondents on average rated the negative version of a factor higher than the positive situation was researchers rating TchInvolv. This means that some researchers believe that involving teachers in research makes them less likely to use research. Our study shows that all other roles rated involving teachers in doing research as significantly more important in influencing teachers’ use of research.

Such a difference between researchers and others reflects debates among researchers. On the one hand, the review by Borg (2010) cites various arguments against the idea that teacher involvement in research is good. For example, “the [limited] validity of the findings in much of this research” (id., p. 404), “that [teacher research] is of poor quality, methodologically-speaking, is also often underpinned by conventional scientific notions of research (e.g., large-scale, replicable, quantitative).” (id., p. 405) or “that in most teaching contexts teachers receive no compensation for the extra work that engaging in research involves.” (ibid.). On the other hand, Gorard and colleagues mention in their review that “Users conducting research themselves is a promising idea that has not really been tested yet” (2020, p. 26).

The idea of research produced by teachers has epistemological implications - the kind of knowledge produced with/by teachers may be necessary to solve "wicked problems in education" (Mosher et al., 2014). It also has political implications - those who decide what is "valuable knowledge for teaching" have power (Dupriez & Cattonar, 2018; Rycroft-Smith, 2022). In a sense, this element of TchInvolv calls into question the nature of the teaching profession (Bourdoncle, 1994) and research (Stenhouse, 1981).

Empirical research is needed to understand the settings in which such participation might be valuable for teachers' use of research, and theoretical research will provide a better conceptualisation of what teachers' use of research entails.

4.1.4 Moderator Effect of the Auxiliary Roles

Although small and of questionable significance, our results indicates an effect of being a trainer on the respondents' judgements and to different views on the factor InstrumUtil. In line with the previous results of this paper, we believe that the discrepancy between teachers and trainers regarding the InstrumUtil factor seems important to investigate in order to better understand its cause and practical consequences. Finally, the role of the trainer seems to have a small but possibly interesting effect on the participants' overall ratings on InstrumUtil. Future research could help to better understand this effect.

4.1.5 Years of Experience in Education

A surprising finding from our study is that there is no effect of years of experience in teaching on participants' ratings of vignettes. This is consistent with Graham and colleagues (2020) who show no effect of years of experience in education on teaching competence. Similarly, years of experience is not a promising way to explain differences in judgments about what influences teachers' use of research.

4.2 Limitations of the Current Study

The most important limitation of our study is that it focuses on the perceptions of educational stakeholders rather than the actual use of research by teachers. It is not because stakeholders believe that institutional support is important in facilitating teachers' use of research that such support has an actual effect in facilitating teachers' use of research. As Gorard et al. put it, 'asking people what they prefer or what they think works can be so misleading'. (2020, p. 17).

A second limitation is that, despite our efforts to clarify the definition and operationalization of each of our factors, the factors had to remain somewhat vague and broad in the situations presented to participants in the vignettes. Further research could address this limitation by breaking down institutional support (or other relevant factors) into 'sub-factors'. In this example, institutional support could be broken down into the provision of time or money for teachers to use research; having only verbal support from the hierarchy; having dedicated trained professionals within schools to help teachers find and interpret research.

A third limitation concerns our sample which may not be representative due to the process, and we had very different respondents between the pilot and main studies in terms of role sharing (57% of teachers for the pilot study versus 80% for the main study). Therefore, our study remains largely exploratory, and future studies in different countries should aim to benefit from institutional support to reach educational stakeholders in a more systematic way, or to collect specific demographic data to be able to compare with large-scale studies such as the Teaching and Learning International Survey (TALIS) (Ainley & Carstens, 2018).

A fourth limitation is that we do not address contexts in which teachers may not want or be able to access research. In our vignettes, it is assumed that the fictional teacher portrayed has accessed research on a topic of interest to her. As with teacher characteristics that may influence teachers' use of research, the issue of teachers' access to research was not included in this study and may be worth exploring in parallel.

A fifth limitation is that our study took place in France, and results may differ from country to country, as the research culture in education may differ, as may the educational settings. It may be interesting to replicate this study in countries with a different educational culture, and whenever necessary, to adapt our study to include variables specific to the educational context and environment studied.

A sixth limitation is that our study had a surprising, slightly significant vignette effect, which is not expected according to Auspurg & Hinz (2015). Nevertheless, we removed it from our model because its effect was very small and its significance limited. This effect could be due to an imbalance in the number of respondents for each block. If more important effects emerge in further studies, caution should be exercised in interpreting the results.

4.3 Conclusion

Echoing the concerns of authors such as Cain and colleagues (2019) or Rycroft-Smith (2022), there is a need for a better conceptualization of research use in education. This means, for example, moving beyond Weiss and Bucuvalas' (1980) simple separation of conceptual, instrumental and symbolic research use to include more detailed views of conceptual research use (Cain et al., 2019; Farrell & Coburn, 2016). Promising ideas include creating links with other scientific literatures such as information literacy and ergonomy, or theory of acceptance (Khechine et al., 2016) considering teachers as information seekers (e.g. Boubée & Tricot, 2010) or as users (e.g. Marion, 2018). Furthermore, clarifying the underlying epistemologies and possible consequences of the choices made when conceptualizing the use of research is an important commitment that researchers in our field should make.

Our study makes progress on the need to prioritize the means of supporting teachers' use of research, and to map the different perspectives of educational stakeholders. We hope to leave promising avenues of research for both theoretical and empirical work on teachers' use of research and knowledge brokering.

Chapter 2: Teachers' use of research, evidence, data and knowledge. A systematic review of reviews

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Abstract

Facilitating teachers' use of research, evidence, data, and knowledge has been the focus of extensive research. Previous reviews have questioned the concepts grounding this field as well as the lack of account of power dynamics between teachers and researchers concerning teachers' use and production of research, evidence, data, and knowledge. We conducted a systematic review of reviews to address the lack of clarity regarding the definitions of research, evidence, data and knowledge, to identify how their use by teachers has been conceptualized, to characterize the educational goals associated with their use, and to describe the roles and contextual influences involved. Our review included 32 reviews, of which only 13 provided definitions for research, evidence, data, or knowledge; 18 defined the framework for their use by teachers; and 5 explicitly stated the educational goals that such use could achieve. We identified a wide range of terms characterizing the quality of research, evidence, data, or knowledge, a diverse range of terms describing how its use could be of quality, but little or vague terms referring to the educational goals for teachers' use of research, evidence, data, and knowledge. Additionally, we found tensions regarding the asymmetrical roles of teachers and researchers, highlighting the importance of redefining these roles, including the roles of brokers and leaders, as well as the necessity of cultural, infrastructural, and systemic changes for sustained use of research, evidence, data or knowledge. We linked these findings to four archetypical conceptions of teachers' use of research, evidence, data and knowledge in relation to specific goals and roles. Finally, we suggest building towards two-way horizontal approaches to facilitating teachers' use and production of research, evidence, data and knowledge, consistently with previous research. We conclude with the description of a promising framework to achieve this goal.

Improving teaching practice has been the focus of many educational reforms across the world, directly affecting the teaching profession (Finnigan et al., 2013). A historical cornerstone of the teaching profession is pedagogical freedom: while constrained by a curriculum about what students should learn, teachers have the freedom to teach according to what they think works best. However, about 30 years ago, determining what works best in education began shifting from teachers' professional judgment to researchers' experiments with the evidence-based education movement (Webster, 2009). Since then, teachers have been increasingly expected to use research, evidence or data to guide their teaching (Riordan, 2022). In parallel, researchers have increasingly studied teachers' use of research (Tseng, 2022) or data-based decision making (Schildkamp, 2019) and ways to improve such use through knowledge brokering (Rycroft-Smith, 2022) or research-practice partnerships (Coburn & Penuel, 2016) to name only a few.

As Rycroft-Smith (2022) puts it, when studying teachers' use of research, "the two underlying questions of what constitutes research (knowledge), and what constitutes use, [are] both contested" (id., p. 34). Furthermore, what constitutes quality of both research and its use are also contested, the former being way more studied than the latter (Rickinson et al., 2022; Tseng, 2022). Finally, even when high-quality research leads to high-quality research use, defining quality outcomes remains contentious, as these are judged based on the values and culture of educational stakeholders (Tseng, 2022). As Rickinson and colleagues' (2022) framework of teachers' quality use of research shows, the system in which various actors play roles in teachers' use of research and the responsibilities of each educational professional are important to consider. This systematic review aims to clarify the blurred concepts around teachers' use of research by mapping the concepts used by researchers when studying teachers' use of research, evidence, data and knowledge (REDaK).

1.1 What is 'research' which teachers are supposed to use?

As researchers, we are so familiar with research that we rarely question this concept. When studying the use of research, however, it becomes important to try to clarify what it is that we want teachers to use. A recurrent definition of research is close to that of Lawlor and colleagues "systematic data collection and analysis to answer a pre-defined question, typically through the use of the scientific method" (2019, p. 219), which leaves room for interpretation, and different interpretations may lead to conflictual views of what actually constitutes research. On the one

hand, the No Child Left Behind act in the US (NCBL, 2003) defined scientifically based research with a focus on experimental, especially randomized controlled trials (RCTs) and such focus was maintained by other legislations such as Every Student Succeed Act (ESSA, 2015), focusing on evidence-based programs built upon RCTs and quasi-experiments (Farley-Ripple et al., 2018; Mills et al., 2020). On the other hand, the scientific literature on the teacher research movement in the US characterized research as "Systematic and intentional; Reflective and self-critical; Voluntary; Ethical; Contextual; Cooperative; Public" (Radulović, 2013, p. 445). Cochran-Smith and Lytle describe its goal as "The emphasis is on transforming educational theory and practice toward emancipatory ends" (1999, p. 18). The US policies are mostly grounded in educational research with a positivist epistemological tradition in which the empirical evidence from scientific methods is supposed to give researchers (and ultimately teachers) access to reality about how the world works (Avenier & Thomas, 2015). Teaching research is instead closer to interpretive and critical epistemologies (Radulović, 2013), for which research does not give direct access to reality, but rather aim at maximizing objectivity and intersubjectivity, based on agreed meaning of a socially-constructed interpretation of specific situations (Avenier & Thomas, 2015). While we used US examples here, the policies related to the evidence-based education movement are similar in several countries such as Australia (Productivity Commission, 2016), China (Yao, 2021), Belgium (Dachet & Baye, 2020), or France (Lima & Tual, 2022); and the teaching research movement can also be found worldwide (Radulović, 2013).

From this understanding that the concept of research could be contested (Rycroft-Smith, 2022) and throughout our exploration of the scientific literature related to teachers' use of research, we found out other concepts which could overlap with research without being fully equivalent. For instance, the concept of 'evidence' has widely been associated to research, 'research evidence' being defined as "any systematic and transparent gathering and analysis of empirical data" (Boaz et al., 2019, p. 5) or "knowledge generated through systematic empirical studies that undergo a rigorous process aligned with the type of study conducted" (Finnigan, 2021, p. 3).

While these definitions of research and evidence originated from researchers, it is important to take into account teachers' views of research and evidence. Mills and colleagues (2020) asked 90 educators in the US about how they conceptualize research and compared it to policy documents. They found out that educators' views of research mainly referred to data (e.g., scores from standardized tests and

other contextually relevant kinds of data) for data-based decision-making. Researchers' definitions of data can be broad and include "assessment, school climate, behavioral, snapshot, longitudinal, moment-to-moment, and so on" (Gummer & Mandinach, 2015, p. 2) or "informal data such as classroom observations, [and] formal (i.e., systematically collected) data such as test scores and information about school composition, to research findings and big data" (Goffin et al., 2022). Some other definitions are more specific and include only benchmark assessment data or routine classroom data (Datnow & Hubbard, 2016). Some researchers such as Rickinson and colleagues (2022) excluded 'data' from their review on quality research use, but other researchers investigating teachers' data-based decision making include research as part of the data (e.g., Goffin et al., 2022).

In addition, some researchers have signaled that data use required knowledge such as content knowledge and pedagogical content knowledge (Datnow & Hubbard, 2016; Gerzon, 2015; Hoogland et al., 2016). Reference to knowledge as something teachers can use is central in the literature around knowledge brokering or knowledge mobilization, which are often used interchangeably (Rycroft-Smith, 2022). While no consensual definition of these terms can be found, Rycroft-Smith suggests "a type of mediation and/or boundary spanning [...] which supports knowledge flow between research, practice and policy in a variety of ways" (id., p. 7). Knowledge in this field thus refers to a continuum between research-based knowledge and teachers' professional knowledge.

Overall, the lack of researchers' consistency in defining research, evidence, data and knowledge is of concern. We believe that it is important to better understand what constitutes research, evidence, data and knowledge, and for instance how we can judge their quality, how they are produced and by whom, or how they are communicated.

1.2 What is the 'use' of REDaK that teachers are supposed to undertake?

Having explored various meanings of 'research', 'evidence', 'data' and 'knowledge' (REDaK), we now turn to the understanding of the *use* of REDaK by teachers, among which variations include teachers' use of *research* (e.g., Jeune et al., 2024), of *research evidence* (e.g., Gitomer & Crouse, 2019), or of *research-based information* (e.g., Dagenais et al., 2012). Focusing more on *evidence* use, evidence-based educational movement, using terms such as *evidence-based practice* (e.g., Basckin et

al., 2021) or *evidence-based teaching* (e.g., Barnes et al., 2018). While *data* use can also be found (e.g., Gerzon, 2015), *data-based decision making* (e.g., Hoogland et al., 2016) and *data-driven decision making* (e.g., Datnow & Hubbard, 2016) also appear frequently. Finally, *knowledge* use is rarely framed as such, but rather questions the origin of knowledge through terms such as *academic knowledge* use (e.g., Schaik et al., 2018), but also through concepts such as *knowledge brokering* and *knowledge mobilization* (e.g., Rycroft-Smith, 2022), hereby putting the emphasis on the movement of knowledge across different communities. Some terms refer directly or indirectly to multiple REDaK such as *research evidence* and *academic knowledge*, which contributes to our understanding that it is relevant to group and study them together, as the use of REDaK in general. However, each field developed their own understanding of the use of REDaK with various conceptualizations.

One of the most cited frameworks in the field of teachers' use of research is Weiss and Bucuvalas' (1980), in which they make a distinction between conceptual, instrumental and symbolic or political use of research. *Instrumental* use of research corresponds to teachers making specific decisions or aiming to solve a problem with direct use of research; *conceptual* use of research corresponds to teachers changing their ideas or their reflection on a topic inspired by research; *symbolic*, or *political* use of research corresponds to teachers justifying already made decisions or actions taken based on some research (e.g., Mills et al., 2020). While conceptual and instrumental use are arguably not independent from each other (e.g., Jeune et al., 2024), this framework is appealing because it helps us draw distinctions between simple categories, which probably explains at least partly its success. Doucet (2019) added to their instrumental-conceptual-symbolic model two missing types of use : *imposed* use, which "refers to use mandated by government initiatives to promote evidence-based programs and practices" and *process* use, which "describes the learnings gleaned by practitioners when they engage in research production" (id., p. 1).

This model is compatible with the evidence-based education field in which the main goal seems to be the achievement of teachers' instrumental or even imposed use of evidence about 'what works best' (Gorard et al., 2020). The top-down, one-way, research-to-practice vision of teachers' use of research and evidence, where teachers are mostly seen as participants in research studies, is now increasingly recognized as ill-conceived and ineffective (Rycroft-Smith, 2022). The conceptualization suggested by Farley-Ripple and colleagues (2018) instead emphasize the importance of linking both the production and use of research and

to contrast two communities (Caplan, 1979; Newman et al., 2016): practitioners and researchers. This focus on the relational gap and linking production and use of research is echoed by the work in the field of research-practice partnerships in education, for which the seminal work of Coburn and colleagues (2013) is often cited. Research-practice partnerships share the two-way conceptualization of research production and use under the criteria of *mutualistic* partnership which means that research-practice partnerships "address the needs and goals of all partners" (Cooper et al., 2020, p. 5). This is viewed by Tseng and colleagues (2017) as "a major shift in ideas about research production and use. [...] It is not about bringing research to practice, but about sustaining a dynamic relationship between research and practice" (id., p. 3). This shift can also be found with the concept of practice-based evidence, which, contrary to evidence-based practice, focuses on the practice-to-research relationship.

Shifting away to *research* and *evidence* in which researchers and teachers are two sides of the same coin, the fields related to *data* use seems instead to focus on school professionals, with a frequent absence of researchers altogether. For instance Schildkamp and Kuiper (2010) define data use as "systematically analyzing existing data sources within the school, applying outcomes of analyses to innovate teaching, curricula, and school performance, and, implementing (e.g. genuine improvement actions) and evaluating these innovations" (p. 482). Another recent and comprehensive definition is that data-based decision making "is the general process of collecting ongoing student data and explicitly using the data to modify instruction to improve student performance [...]. Also called data-based instruction [...], data-driven decision-making [...], or data-based individualization [...], these models of data collection and analysis vary slightly across approaches but contain the following common steps [...] that may be repeated as needed: 1. Establish present levels of performance. 2. Set an instructional goal. 3. Deliver instruction. 4. Use data to monitor student progress toward the goal. 5. Use decision rules to evaluate student progress and instructional effectiveness. 6. Hypothesize about the student's progress and instructional needs. 7. Implement changes to instruction. 8. Repeat the cycle." (Ruhter & Karvonen, 2024, p. 45). As such, teachers' data use does not seem to imply any involvement of researchers but requires the creation of a culture of data use in schools (Gerzon, 2015).

In the context of *knowledge* use, brokerage may correspond to the first, top-down approach, in the case of "Knowledge brokers as individuals applying knowledge brokering strategies to transfer knowledge from research to practice" (Rechsteiner

et al., 2023, p. 14). But brokers may also "facilitate [two-way] boundary crossing between research and practice" (Sjölund et al., 2023). As such, the understanding of the knowledge source and nature is important to understand how it flows between teachers and other educational professionals (mainly researchers). Teachers may acquire new knowledge from researchers, but the reverse is also true.

Of course, the various frameworks for teachers' use of REDaK can be combined as in Penuel and colleagues' (2020) review, which focuses on teachers' use of research and data in research-practice partnerships. But the way the frameworks for teachers' use of REDaK are defined, what quality use they entail (Rickinson et al., 2020, 2022), what processes of such use they entail (Tseng, 2022), and how such use is supposed to occur, may vary from one study to the other.

As for the concepts of REDaK, the diversity of frameworks for teachers' use of REDaK makes it difficult to conceptualize clearly what the use of REDaK is. But this quest is further complexified when we try to take into account the underlying educational goals associated with different conceptualizations of teachers' use of REDaK, and possible consequences of unclear conceptualizations in this regard.

1.3 What outcomes of teachers' use of REDaK are expected?

While the previous sections contributed to investigate *what* teachers' use of REDaK is, we now contrast various perspectives about *why* teachers should use REDaK. Tseng (2022) saw the study of teachers' use of research evolve from descriptive research about *what* teachers' use of research is, towards a focus on *how* to facilitate teachers' use of research in practice. Likewise, we believe it is now time to move from *what* and *how* towards a deep questioning of *why* and *what for* teachers should use REDaK.

As Tseng put it "Hard truths have emerged" (2022, p. 5) from the new step in this direction taken by Doucet (2019), using a critical race theoretical framework to study the use of research. She questioned both how research is produced and how it is used, and reminded us that "research has been historically and contemporaneously (mis)used to justify a range of social harms" (id., p. 2). Marginalized, racialized students may benefit less, or end up worse off, due to a restrictive vision of teachers' use of research. Her work should encourage researchers to consider *by whom* research is produced and *to whom* it is useful and relevant, and link it to the educational goals pursued in relation to teachers' use of REDaK.

Similar concerns have been raised about the evidence-based educational movement, which often overlooked the power stakes related to defining to whom teachers' use of REDaK may benefit, focusing instead on questions about effectiveness or 'what works' (Cain, 2016; Sjölund et al., 2023). In his most cited papers, Biesta (2007, 2009, 2010) made the case for a value-based vision of education instead of an evidence-based one, arguing that effectiveness always comes after a judgment of what is a desirable outcome. This means that 'what works' questions necessarily include an implicit vision of educational aims, which, when left unquestioned, may be related to dominant values. The choice of a research question, the definition of the concept under study, the protocol to evaluate the effectiveness of an educational intervention related to that definition, and the methods used to analyze the data as well as the researchers' interpretation are not neutral. It is therefore important to better understand what researchers report in relation to educational goals, or what a desirable, 'good education', 'good teaching' and 'good learning' could look like, at the student, teacher or school level, but also what specific problem teachers' use of REDaK is trying to solve.

1.4 What roles and context influences teachers' use of REDaK?

In the context of teachers' use of REDaK, we could see an opposition between one-way, or top-down visions of teachers' use of REDaK as opposed to two-way, or horizontal visions of teachers' use of REDaK. This takes place with the very nature of the teaching profession at stake. The opposition here is between teachers "as active agents of improvement rather than as passive receivers of knowledge developed by others" (Bryk, 2015, p. 469). While teachers are not oppressed by researchers, we believe that critical lenses on the power relationships between researchers and teachers in relation to the institutions, systems, and structures influencing their work are welcome to better understand the field of teachers' use of REDaK.

While the framework suggested by Farley-Ripple and colleagues (2018) set apart two communities, the research field of brokerage adds a layer of complexity. Indeed, knowledge brokers may not only be various types of individuals but also organizations, which opens the door to other ways to conceptualize the various roles played by different stakeholders regarding teachers' use of REDaK. As Rickinson and colleagues' (2022) framework of quality use of research evidence shows, there is also the necessity to take into account the different education

professionals' relationships, as well as the leadership, culture, infrastructures and system they are all embedded in.

As for the previous sections, the roles of each educational stakeholder in relation to teachers' use of REDaK, as well as contextual and structural components, may be more or less precisely defined by researchers studying the field. The connection between the roles and structures with the definition of REDaK, their use by teachers and the goals for such use may yield valuable insights about what we are collectively studying.

1.5 Aims and research questions

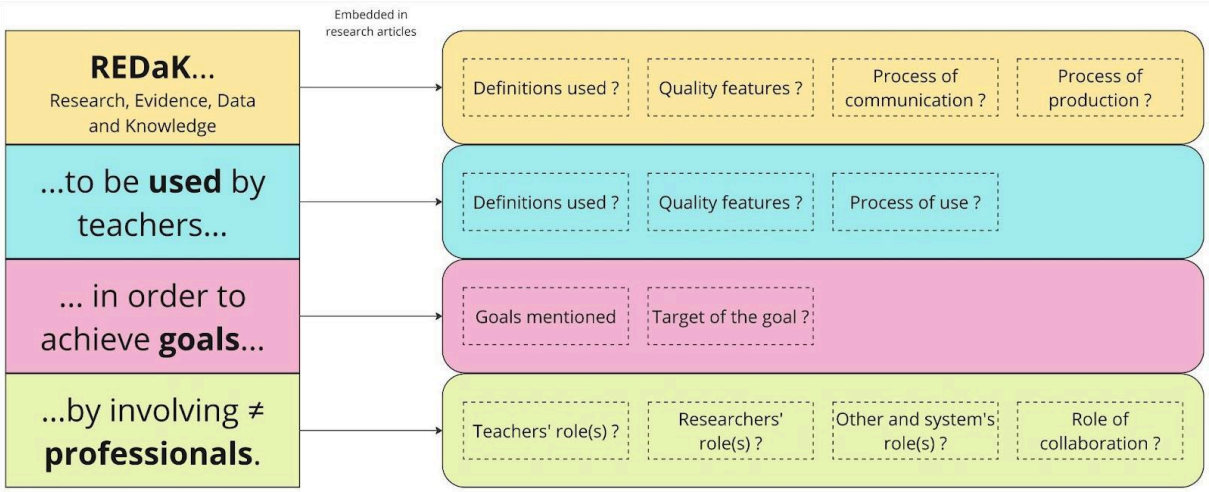
Reviews of the scientific literature, especially systematic reviews, tend to be cited more frequently than original articles (Montori et al., 2003; Royle et al., 2013), and may play a high role in shaping a research field. As the various fields of teachers' use of REDaK have seen many reviews published, we decided to focus on these reviews to ask the following questions:

1. Which conceptions of 'research', 'evidence', 'data' and 'knowledge' (REDaK) for teachers' use are conveyed in research articles?
2. Which conceptions of the use of REDaK are conveyed in research articles?
3. For which educational goals is the use of REDaK advocated in research articles?
4. Which conceptions of the teaching profession, the research profession, other educational stakeholders and the systems they are part of are conveyed in research articles regarding teachers' use of REDaK?
5. To what extent is the use of specific concepts related to teachers' use of REDaK connected to some educational aims or views of the teaching profession?

The following figure (Fig. 1) is a graphical representation of the space of questions we address in this article, each of the four different spaces represent the first four questions, while our last question corresponds to the connection of the four blocs.

Figure 1.

A visual representation of our research questions.



2. Method

In order to answer our research questions, we conducted a systematic review (Page et al., 2021) of the peer-reviewed, published reviews of the literature focusing on K-12 general education teachers' use of REDaK.

2.1 Inclusion and exclusion criteria

Our inclusion criteria were that articles had to be written in english, peer-reviewed, with the main focus on K-12 general education teachers' use of REDaK, in general or in relation to a specific field of research (e.g., educational sciences, neurosciences), and the main method should explicitly be a review of the scientific literature (possibly including book chapters, gray literature, etc.). We excluded articles for which the review was not the main method of the article (e.g., purely theoretical article, review method not explicitly defined, primary empirical study), which focused mainly on teachers outside of the K-12 scope, not in general education (e.g., special education) or mostly on other educators, or focusing on implementation of a specific research-based practice. These criteria have evolved throughout the first stages of screening in order to reduce the interpretation and to reach more reproducible results.

2.2 Search strategy

In February 2024, we searched without date limitations four databases including educational research: ERIC, EBSCO, Scopus and Web of Science, selecting the

options (whenever available) to see only peer reviewed articles and to look into the title, abstract and keywords, using the following search equation:

- ("evidence-based practice" OR "evidence-based education" OR "use of research" OR "disseminate research" OR "evidence-based teaching" OR "knowledge mobilization" OR "knowledge translation" OR "knowledge utilization" OR "knowledge brokering" OR "research-practice partnerships" OR "theory-practice gap" OR "research-informed teaching" OR "data-based decision-making" OR "academic knowledge utilisation" OR "contribution of research")
- AND review
- AND (teachers OR "school practitioners" OR "K-12 education" OR "knowledge brokering in education").

This search equation was slightly adapted for the SCOPUS database, which had to start with TITLE-ABS-KEY and was otherwise identical. Our search equations were constructed based on our knowledge of relevant concepts to include, in particular making sure that the relevant reviews we already knew could be found with our equation. For instance, the last term "knowledge brokering in education" was added due to our knowledge of a relevant review which wasn't found with the other search terms. Otherwise, the first part of the search terms included all terms related to teachers' use of REDaK, then "review" was added to constrain the studies based on their methodological design, and the last part of the search terms corresponded to constraints about the target population of the reviews (K-12 general education teachers).

2.3 Screening

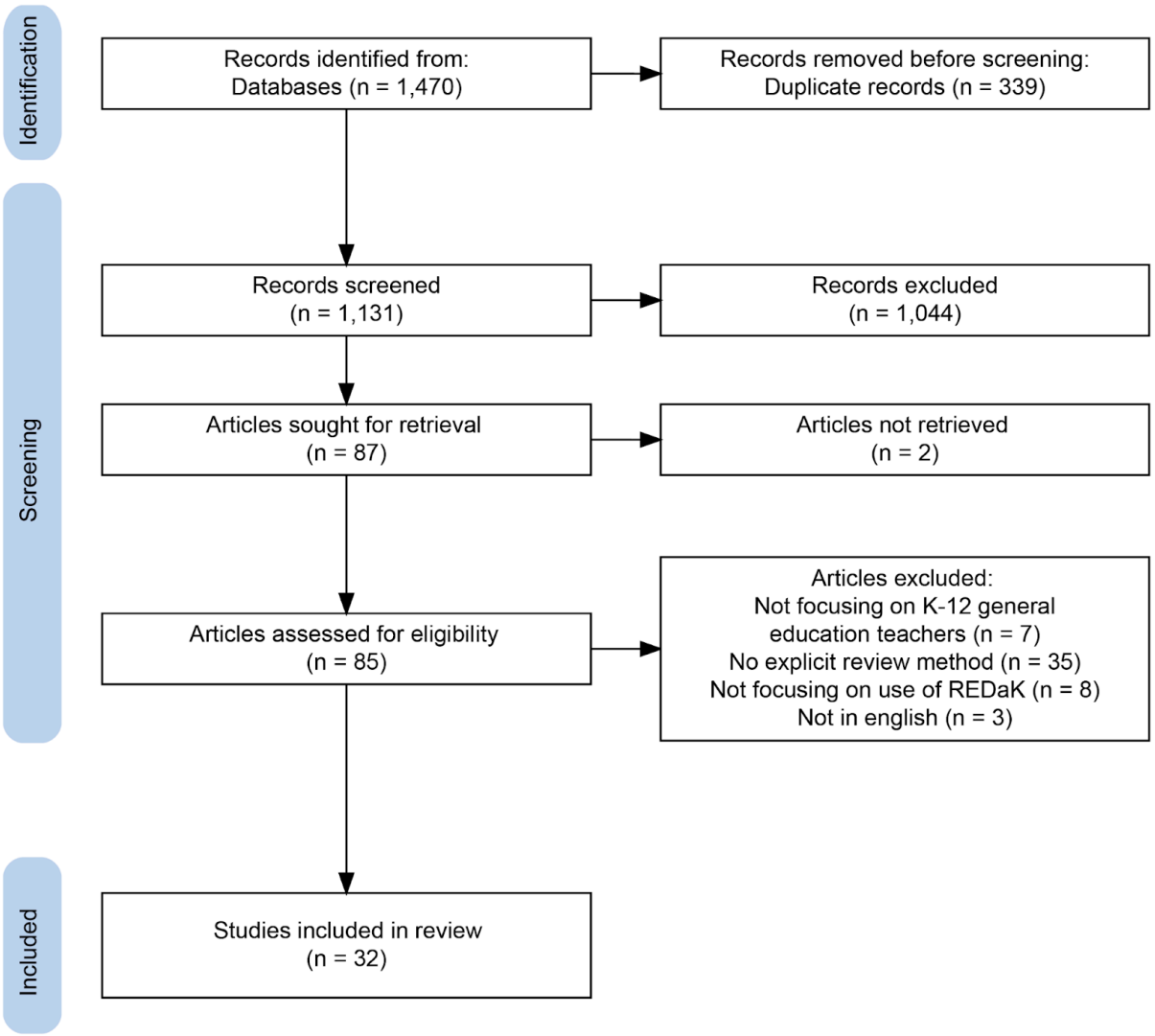
The list of records from each database was uploaded to Rayyan (https://new.rayyan.ai/), an online tool designed to help with systematic reviews from which we used the free version between February and March, 2024. From the 1,470 articles found across the four databases (ERIC: 493; EBSCO: 729; Scopus: 412; WoS: 89), one author manually resolved possible duplicates to end up with a total of 1,131 articles for screening. Then, two authors did the screening based on title and abstract across three phases. During the first phase, 57 articles were randomly selected and independently screened. Conflicts were then resolved by consensus, and whenever necessary, the opinion from a third author (PD) helped achieve

consensus. The inclusion and exclusion criteria were adapted accordingly, and then the second phase started with another random selection of 100 articles subject to independent screening with similar settings. After new improvements of the inclusion–exclusion criteria, the rest of the articles were screened blindly by two authors, and consensus was reached after discussion in case of disagreement.

We downloaded the full text from the selected articles based on their title and abstract for final screening, and whenever we could not access the full text, we contacted the authors asking for the article. The articles were excluded in case the authors did not share the otherwise inaccessible full text. For all articles eventually included at this stage, the two authors who did the screening then blindly did the full text screening and discussed to reach consensus in case of disagreement. A total of 32 articles were included in the final study. The PRISMA flowchart (Fig. 2) summarizes the full process of our review.

Figure 2

PRISMA flowchart of our systematic review



2.4 Data extraction

We created a table for data extraction making sure that each kind of data to be extracted was relevant to answer our research questions. We randomly selected three articles from which two authors (NJ & IA) independently extracted the data and then discussed disagreements until reaching consensus. We made changes in the data extraction table based on what needed clarification, and missing categories which could be relevant to answer the research questions. Another article was randomly selected for double, independent data extraction which led to small adjustments. For the remaining 28 articles, a single author (NJ) extracted the data, and two other authors (IA & PD) suggested improvements.

2.4.1 Descriptive elements

The data extracted included the following descriptive elements for each study: Year of publication, Journal, Aims and focus of the review, Type of review, Number of records included in the review and Type of records included.

2.4.2 Conception of REDaK to be used by teachers

We extracted verbatim related to the conception of REDaK to be used by teachers in order to answer our first research question. In particular, we searched for the conceptions of REDaK to be used by teachers specifically, and did not extract elements related to researchers' views of research in general. We extracted explicit or implicit definitions or characteristics of REDaK as well as their quality features, how they are produced and by whom, how they are communicated, how they can be distinguished from something else, and what they focus on.

2.4.3 Conception of teachers' use of REDaK

We extracted verbatim related to the conception of teachers' use of REDaK in order to answer our second research question. In particular, we searched for explicit or implicit definitions or characteristics of such use of REDaK, features for the quality *use*, as well as explanations of the process of such use or how such use is supposed to occur. Furthermore, we selected the main concept (or main concepts, in case more than one appeared to be of major importance in the review) used in the review related to teachers' use of REDaK, and a justification of this choice whenever needed.

2.4.4 Conception of 'good education' or educational goals that the use of REDaK intends to help teachers achieve

We extracted verbatim related to the educational goals underlying teachers' use of REDaK, including the expected end result of teachers' use of REDaK, the problem that it was meant to solve, or more general statements about what good education, good teaching or good learning is.

2.4.5 Conception of educational stakeholders' professions, roles and interactions in relation to teachers' use of REDaK

We extracted verbatim related to the conception of the role and profession of teachers in relation to their use of REDaK, and likewise for researchers' role and profession. We also extracted the conceptions of the role of other educational stakeholders as well as systemic or structural elements related to teachers' use of

REDaK, and the conceptions regarding the interactions between teachers, researchers and other stakeholders in relation to teachers' use of REDaK.

2.4.6 Links between REDaK, their use, the goals and professionals involved

Based on the previous categories related to each of our first four research questions, we built archetypes of global conceptions of teachers' use of REDaK from a mix of elements found in each category (REDaK, use, goals and roles). Each archetype corresponds to a unique mix, not necessarily found in one article, but illustrating a pattern found across a specific field of the use of REDaK.

2.5 Analysis

In the first phase, we used an iterative, open coding of the data extracted (Gough et al., 2017), which consisted in categorizing the data and refining the categories in order to best represent our interpretation of the meaning across all included studies. For instance, we grouped similar terms referring to REDaK when they had similar phrasing and definitions, and placed them in different categories when they conveyed different visions. Likewise, we categorized different visions of teachers' use of REDaK, different educational goals, and different roles in order to answer respectively our first four research questions. In the second phase, we compared our categories to already existing frameworks, in particular Doucet's (2019) extension of Weiss and Bucuvalas' (1980) framework for teachers' use of research and Rickinson and colleagues' (2022) framework for quality use of research evidence.

We then took a step back to answer our last research question about the connections between those elements. We cross-analyzed the various categories in order to see emerging patterns, which we used as archetypal categories of researchers' views on teachers' use of REDaK in relation to underlying educational goals and professional roles.

The analysis was conducted by one author (NJ) which was iteratively improved based on the discussion with the other authors until the categories adequately explained all the data included in our systematic review. We used illustrative quotes throughout the process to justify and clarify the various categories and the reason why each article was assigned to one or another.

3. Results

The full dataset is available on the following online repository: https://osf.io/nd5kt/?view_only=36ed3482be7e47f5acb7b3e42a7d52ba

3.1 Sample description

Among the 32 reviews included, the majority (21) used a standardized design such as a systematic review, even though they varied slightly in their process, and 2 reviews were classified as narrative. Among the remaining studies, 2 consisted of other designs and 7 did not report with enough details the method used. Four reviews did not explicitly report the number of articles included, and among the remaining 28 reviews, the number of articles included ranged from 8 to 149, with a mean of 46.8 and a median of 36.5. The oldest published review included in our systematic review was the seminal work of Hemsley-Brown and Sharp (2003), and the median year of publication was 2020, leaving only 6 reviews published in 2015 or before. This stresses the growth of the fields included in our review in the past few years, with an exponential increase of the number of reviews published in relation to teachers' use of REDaK. *Teachers College Record* gathered a total of 5 publications included in our review, the *Review of education* 4 publications, and the *International Journal of Educational Research* 3 publications, while the other journals included only one or two publications each. In total, 9 out of the 32 articles were published in journals specialized in publishing reviews.

Table 1 below summarizes the articles included in our review, according to whether they focused on empirical papers only, english publications only, peer-reviewed content only, as well as the time frame of the studies they included.

Table 1.

Description of the type of publications included in the reviews.

Type of publications included in the review								
Empirical only	Mixed	NA	English only	Mixed	NA	Peer-reviewed only	Mixed	NA
8	6	18	12	1	19	15	9	8

3.2 Conception of REDaK to be used by teachers

Research, Evidence, Data and Knowledge appear to various extents in the reviews included in our review, respectively 24, 22, 16 and 10 times across all 32 articles. Most of the articles used many terms: only 8 articles used only one of the four terms in relation to what teachers are supposed to use. Among the articles using various terms, 11 used two terms, 10 used three terms, and only 3 articles used all four terms. Interestingly, Knowledge and Data almost never appear together in the same article, unless Research and Evidence also appear.

3.2.1 Definitions of the main concepts of REDaK

For each of our four concepts of REDaK, we counted the number of explicit definitions (Table 2) and put in Appendix 1 the citation of each definition.

Table 2.

Number of definitions of each REDaK.

Research	**Definitions found in 5 articles** (Dagenais et al., 2012; Pereira et Fang, 2022; Schaik et al., 2018; Sjölund et al., 2022; Wei & Huang, 2022)
Evidence	**Definition found in 1 article** (Piety, 2019)
Data	**Definitions found in 7 articles** (Cooper et al., 2020; Datnow & Hubbard, 2015; Goffin et al., 2022; Harshman & Yezierski, 2017; Marsh, 2012; Piety, 2019; Ruhter & Karvonen, 2024)
Knowledge	**Definition found in 1 article** (Rycroft-Smith, 2022)

A total of 13 articles gave an explicit definition of a REDaK item, and only 1 article explicitly defined two REDaK items, which means that more than half of the articles did not define any REDaK item.

3.2.2 Quality features of REDaK

Beyond the explicit definitions, several articles used terms which could be interpreted as quality features of REDaK. According to Rickinson and colleagues' "Components of the Quality use of research evidence (QURE) framework" (2022, p. 142), one of the core components is the appropriateness of research evidence, which we will expand in the context of this study to the quality features of REDaK,

keeping in mind that the appropriateness is a core dimension to conceptualize the quality *use* of REDaK. But in order to expand it, we added other categories of quality features of REDaK as they appeared in the reviews analyzed, which we grouped when they seemed similar, as shown in Table 3. The verbatim of the different article citing these quality features can be found in appendix 2.

Table 3.

REDaK quality features.

REDaK quality features (number of articles citing it)	**Articles citing quality features of REDaK according to the types of REDaK mentioned**
Relevant or worthwhile (7)	**Research** (Cain, 2016; Dagenais et al., 2012; Hemsley-Brown & Sharp, 2003; Pereira et Fang, 2022; Schaik et al., 2018; Sjölund et al., 2022; Wang et al., 2023) **Evidence** (Cain, 2016; Dagenais et al., 2012; Hemsley-Brown & Sharp, 2003; Pereira & Fang, 2022; Sjölund et al., 2022) **Data** (Hemsley-Brown & Sharp, 2003; Pereira & Fang, 2022) **Knowledge** (Cain, 2016; Dagenais et al., 2012; Hemsley-Brown & Sharp, 2003; Pereira & Fang, 2022; Schaik et al., 2018)
Timely or up-to-date or with longevity (7)	**Research** (Dagenais et al., 2012; Hemsley-Brown et Sharp, 2003; Jones et al., 2022; Penuel et al., 2020; Sjölund et al. 2023; Wei & Huang, 2022) **Evidence** (Dagenais et al., 2012; Hemsley-Brown et Sharp, 2003; Hoogland et al., 2016; Jones et al., 2022; Sjölund et al. 2023) **Data** (Hemsley-Brown et Sharp, 2003; Hoogland et al., 2016; Penuel et al., 2020; Sjölund et al. 2023) **Knowledge** (Dagenais et al., 2012; Hemsley-Brown et Sharp, 2003; Jones et al., 2022)

Usable, practical, provide suggestions or applicable (6)	**Research** (Cain, 2016; Dagenais et al., 2012; Grima-Farrell et al., 2011; Piety, 2019; Schaik et al., 2018) **Evidence** (Cain, 2016; Dagenais et al., 2012; Grima-Farrell et al., 2011; Hoogland et al., 2016; Piety, 2019) **Data** (Hoogland et al., 2016; Piety, 2019) **Knowledge** (Cain, 2016; Dagenais et al., 2012; Grima-Farrell et al., 2011; Piety, 2019; Schaik et al., 2018)
Credible or convincing or consistent or trustworthy or verifiable or reliable (6)	**Research** (Cain, 2016; Dagenais et al., 2012; Grima-Farrell et al., 2011; Phelps, 2019) **Evidence** (Cain, 2016; Dagenais et al., 2012; Grima-Farrell et al., 2011; Hoogland et al., 2016; Marsh, 2012) **Data** (Hoogland et al., 2016; Marsh, 2012; Phelps, 2019) **Knowledge** (Cain, 2016; Dagenais et al., 2012; Grima-Farrell et al., 2011)
User friendly, readable, formated, rescaled explicit, of appropriate design, easy to interpret or formalised (6)	**Research** (Hemsley-Brown et Sharp, 2003; Jones et al., 2022; Penuel et al., 2020; Piety, 2019; Rycroft-Smith, 2022) **Evidence** (Hemsley-Brown et Sharp, 2003; Hoogland et al., 2016; Jones et al., 2022; Piety, 2019; Rycroft-Smith, 2022) **Data** (Hemsley-Brown et Sharp, 2003; Hoogland et al., 2016; Penuel et al., 2020; Piety, 2019) **Knowledge** (Hemsley-Brown et Sharp, 2003; Jones et al., 2022; Piety, 2019; Rycroft-Smith, 2022)
Valid or generalizable (6)	**Research** (Dagenais et al., 2012; Goffin et al., 2022; Pereira & Fang, 2022; Schaik et al., 2018) **Evidence** (Dagenais et al., 2012; Hoogland et al., 2016; Marsh, 2012; Pereira & Fang, 2022) **Data** (Goffin et al., 2022; Hoogland et al., 2016; Marsh, 2012; Pereira & Fang, 2022) **Knowledge** (Dagenais et al., 2012; Pereira & Fang, 2022; Schaik et al., 2018)

Accessible (5)	**Research** (Grima-Farrell et al., 2011; Rycroft-Smith, 2022; Schaik et al., 2018) **Evidence** (Grima-Farrell et al., 2011; Hoogland et al., 2016; Rycroft-Smith, 2022) **Data** (Harshman & Yezierski, 2017; Hoogland et al., 2016) **Knowledge** (Grima-Farrell et al., 2011; Rycroft-Smith, 2022; Schaik et al., 2018)
Useful (4)	**Research** (Dagenais et al., 2012; Sjölund et al. 2023; Wang et al., 2023) **Evidence** (Dagenais et al., 2012; Hoogland et al., 2016; Sjölund et al. 2023) **Data** (Hoogland et al., 2016; Sjölund et al. 2023) **Knowledge** (Dagenais et al., 2012)
Objective or systematic or impersonal (4)	**Research** (Basckin et al., 2021; Goffin et al., 2022; Schaik et al., 2018) **Evidence** (Hoogland et al., 2016) **Data** (Goffin et al., 2022; Hoogland et al., 2016) **Knowledge** (Schaik et al., 2018)
Public, open or shareable (3)	**Research** (Dagenais et al., 2012; Jones et al., 2022; Phelps, 2019) **Evidence** (Dagenais et al., 2012; Jones et al., 2022) **Data** (Phelps, 2019) **Knowledge** (Dagenais et al., 2012; Jones et al., 2022)
Scientific, quantitative, rigorous (3)	**Research** (Basckin et al., 2021; Cain, 2016; Sjölund et al. 2023) **Evidence** (Cain, 2016; Sjölund et al. 2023) **Data** (Sjölund et al. 2023) **Knowledge** (Cain, 2016)
Practice-informed (1)	**Research** (Rycroft-Smith, 2022) **Evidence** (Rycroft-Smith, 2022) **Knowledge** (Rycroft-Smith, 2022)
Comprehensive (1)	**Evidence** (Hoogland et al., 2016) **Data** (Hoogland et al., 2016)

This table shows that many of the quality features of REDaK can be found across articles mentioning all four concepts, and as such may not be devoted to a specific view of what a REDaK is. However, the extent to which each quality feature is cited is highly variable, and no quality feature is cited more than 7 times across all 32 articles (Relevant or worthwhile; timely or up-to-date or with longevity), while some quality features are cited only once (Practice-informed and comprehensive). In total, slightly more than half of the articles (19/32) cited at least one of these quality REDaK features, which leaves a large part of the articles which did not detail what quality REDaK is.

The above quality features consider REDaK as *products* to be used by teachers rather than *processes*. We also found the following terms to be related to REDaK, but rather as processes, or which referred to the product but could not be separated from their use. Processes include participatory, local, sharing ownership, emancipatory, RCTs. Quality products associated with use only include effective, efficient, impactful, what works.

3.3 Conceptions of teachers' use of REDaK

3.3.1 Definitions of the main concepts related to teachers' use of REDaK

There were a wide variety of terms used to describe teachers' use of REDaK across the different reviews included in our review. We grouped some because of the very similar terms and/or theoretical frameworks they referred to. Each article had one or two main concepts, among which the two most popular were data use and similar concepts such as data-based decision making (10/32 articles), and research-practice partnerships (9/32 articles). Table 5 below describes the number of articles in which each main concept is explicitly defined. The available definitions can be found in the appendix 3.

Table 5.

List of articles providing explicit definitions of the main concepts of the use of REDaK.

	List of articles providing an explicit definition of the use of REDaK

Data use, data-based decision-making, data-driven inquiry, data-driven decision-making	**Definitions found in 6 articles** (Datnow & Hubbard, 2015, 2016; Harshman & Yezierski, 2017; Hoogland et al., 2016; Piety, 2019; Ruhter & Karvonen, 2024 **Definition missing in 4 articles** (Goffin et al., 2022; Marsh, 2012; Mitchell et al., 2018; Penuel et al., 2020)
Research-practice partnerships (RPP) or school-university partnerships	**Definitions found in 8 articles** (Cooper et al., 2020; Penuel et al., 2020; Pereira & Fang, 2022; Phelps, 2019; Sjölund et al., 2022, 2023; Vetter et al., 2022; Wei & Huang, 2022) **Definition missing in 1 article** (Shaik et al., 2018)
Implementation of evidence-based practices, use of EBP,	**Definitions found in 3 articles** (Dagenais et al., 2012; Goddard et al., 2022; Merle et al., 2022) **Definition missing in 3 articles** (Basckin et al., 2021; Goddard et al., 2022; Shelton et al., 2023)
Use of research, use of research evidence, use of research-based information or academic knowledge utilisation	**Definitions found in 4 articles** (Dagenais et al., 2012; Rycroft-Smith, 2022; Schaik et al., 2018; Sjölund et al., 2022) **Definition missing in 1 article** (Cain, 2016)
Knowledge mobilisation, knowledge brokering, brokerage	**Definitions found in 2 articles** (Rechsteiner et al., 2023; Rycroft-Smith, 2022)
Theory-to-practice gap, research-to-practice gap	**Definition missing in 2 articles** (Grime-Farrell et al., 2011; Phelps, 2019)
Sensemaking	**Definition found in 1 article** (Goffin et al., 2022)
Research-teaching nexus	**Definition found in 1 article** (Wang et al., 2023)
Translational research	**Definition found in 1 article** (Jones et al., 2022)
Research dissemination, knowledge dissemination	**Definition missing in 1 article** (Hemsley-Brown & Sharp, 2003)

If we take into consideration not only the main concept at hand in the articles we analyzed, but also the secondary concepts, we found that most articles mention several concepts, most of which are never explicitly defined. Only 18 articles reported explicit definitions of the main concept used related to teachers' use of REDaK.

3.3.2 Terms used to describe teachers' use of REDaK

We have found a wide variety of terms describing the process of the use of REDaK, which can express various stages of use, can focus on different dimensions of use, or can be related to different goals for use. Another core component from Rickinson and colleagues' (2022) quality of use framework is the thoughtful engagement and implementation which they describe as "Critical engagement with the research evidence, shared deliberation about its meaning and effective integration of aspects of the evidence within practice" (id., p. 142).

Table 6.

Features regarding the quality use of REDaK.

Quality use features	Articles citing quality features of teachers' use of REDaK according to the different concepts of use of REDaK
Fidelity of implementation	**Evidence-based practices** (Goddard et al., 2022; Hepburn et Beamish, 2019; Merle et al., 2022; Shelton et al., 2023) **Data use** (Gerzon, 2015; Harshman & Yezierski, 2017; Mitchell et al., 2018; Ruhter & Karvonen, 2024).
Consistency of use	**Data use** (Datnow & Hubbard, 2015; Gerzon, 2015; Hoogland et al., 2016; Marsh, 2012) **Evidence-based practice** (Merle et al., 2022) **Research-practice partnerships** (Vetter et al., 2022)
Depth of adoption	**Data use** (Marsh, 2012)
Combine knowledge sources	**Data use** (Datnow & Hubbard, 2016; Harshman & Yezierski, 2017) **Brokerage** (Rycroft-Smith, 2022)

Recognition and articulation of problems	**Data use** (Goffin et al., 2022; Penuel et al., 2020) **Research-practice partnerships** (Penuel et al., 2020) **Sensemaking** (Goffin et al., 2022)
Sense or meaning making	**Data use** (Datnow et Hubbard, 2016; Gerzon, 2015; Goffin et al., 2022; Penuel et al., 2020; Phelps, 2019) **Research-practice partnerships** (Penuel et al., 2020) **Use of research** (Cain, 2016) **Brokerage** (Rechsteiner et al., 2023) **Sensemaking** (Goffin et al., 2022)
Challenging assumptions	**Brokerage** (Rycroft-Smith, 2022)
Depth of investigation	**Research-practice partnerships** (Cooper et al., 2020; Sjölund et al., 2022, 2023; Vetter et al., 2022)
Students needs integration	**Data use** (Hoogland et al., 2016; Ruhter & Karvonen, 2024) **Evidence-based practice** (Basckin et al., 2021) Brokerage (Rycroft-Smith, 2022)
Address issues of power and equity	**Research-practice partnerships** (Penuel et al., 2020; Pereira & Fang, 2022; Vetter et al., 2022)
Mutualistic and horizontal	**Research-practice partnerships** (Cooper et al., 2020; Pereira & Fang, 2022; Sjölund et al., 2022, 2023; Vetter et al., 2022)

Several categories of the quality use of REDaK seems to be specific to only one main concept of teachers' use of REDaK. For instance, research-practice partnerships is the only concept focusing on the mutualistic and horizontal dimension of teachers' use of REDaK though it is widely cited. Likewise, the depth of adoption seems related to the field of data use, but the fact that it was only cited once should be interpreted with caution. The sense-making feature is instead a widely shared feature regarding the quality of use of REDaK, with five different fields citing it.

Overall, better described than quality features of REDaK, 24 articles cited features related to the quality of use of REDaK, which leaves one out of four articles without expressing any of these features.

3.3.3 Other terms used to describe teachers' use of REDaK

The majority of the terms used to describe teachers' use of REDaK did not fully fit the *quality use* focus of Rickinson and colleagues' (2022) framework. We thus categorized the other terms in reference to Weiss and Bucuvalas' (1980) *instrumental-conceptual-symbolic* use of research, with the adaptation from Doucet (2019) who added *imposed* and *process* use of research. We eventually added a new category, *relational* use, which we define as all elements of the use process referring to the relational dimension between individuals across structures and institutions.

When a term describing a process of use could fit many boxes, we decided to write it multiple times (marked with an asterisk*), thus taking into account the limitation of this model as the categories are not mutually exclusive.

Table 7.

Terms describing the process of teachers' use of REDaK according to different types of use.

	Other terms describing the process of teachers' use of REDaK
Instrumental use	Disseminate, translate, implement, apply, actionable, transfer, systematic*, synthesise, test, adhere, turn into practical application, facilitate change, solve problem, modify instruction, adjust instruction,
Conceptual use	Interpret, prioritize, inform, understand, question, diagnose, gain insight, design, analyze, guide decisions, define a problem, recognize and articulate problems, formulate workable improvement actions, triangulate, produce original analyses*, generate new theories*, model, examine, search for coherence, name and challenge assumptions, define a problem, judge process,
Symbolic use	

Process use	Gather, systematic*, access, filter, share, find, collect results, mutually produce, coordinate, equitable, adapt, organize, bridge the gap, produce original analyses*, generate new theories*, take time, co-construct*, co-develop solutions*, determine students' thought processes, cycle, refine, modify to better fit the context, generate evidence / knowledge, transform, overcome barriers, determine the instructional effectiveness, act on, engage with, mobilize, integrate, employ, enable, prepare, alter,
Imposed use	Top-down, theoretical-driven, contention
Relational use	Dialog, clear expectations, discuss, respond to, social relationship, collaborate, network, build connections, provide training, shared expertise, human activity, safe environment, skills growth, integrity, interact, relational, identity, understand another point of view*, human-centered, collective, negotiate, co-construct*, provoke debate, co-develop solutions*, build trust, persuade, connect,

3.4 Conceptions of educational goals that the use of REDaK intends to help teachers achieve

3.4.1 Definitions of the goals behind teachers' use of REDaK

Out of the 32 articles reviewed, the large majority used vague or mostly implicit goals for teachers' use of REDaK, consistently with previous findings such as Dagenais and colleagues (2012) who stated that « Purpose of use of research-based information was rarely reported. Consequently, not much is known about the ends to which practitioners apply research in their teaching practice » (id., p. 295). The only explicit definitions of educational goals that the use of REDaK intends to help teachers achieve in the articles reviewed are the following:

Table 8.

Definitions of the goals behind teachers' use of REDaK.

	Definitions of the goals behind teachers' use of REDaK

Impact on practice	"review defined impact on practice as being a change in an existing practice that could be observed and was not fundamentally at some higher level of abstraction (e.g., the school system). Impact in this review did not only mean a change in an outcome variable with any quantitative confidence but rather any positive or negative observable change in practice resulting from the inclusion and use of some data in a regular educational activity rather than outside of a practice setting" (Piety, 2019, p. 401).
Implementation outcomes	"Implementation outcomes are defined as '...the effects of deliberate and purposive actions to implement new treatments, practices, and services' (Proctor et al., 2011, p. 65). Implementation outcomes are adult-facing, concerned with whether effective practices are adopted as planned—compared to effectiveness or efficacy outcomes, which are child-facing, and are concerned with whether the practice led to improvements in functioning of the students, patients, or clients receiving the practice" (Merle et al., 2022, p. 3).
School-level outcomes	"school-level outcomes included improvements in (a) risk and protective factors known to buffer school violence and discipline problems (Sprague et al., 2001); (b) the development and use of school discipline policy (Ward & Gersten, 2013); (c) frequency and duration of school suspensions (Ward & Gersten, 2013); (d) overall organizational health, resource influence, and staff affiliation (Bradshaw, Koth et al., 2008; Bradshaw, Koth, Thornton, & Leaf, 2009); and (e) perceptions of the safety and quality of the school environment (Horner et al., 2009) (Michell et al., 2018, p. 10).
Inclusion	"inclusion is described and defined as an approach focused on responding to the diversity of student needs in ways that are beneficial to students with (O'Neil, 1994; Salend & Duhaney, 1999; Smith, Polloway, Patton, & Dowdy, 1998) and without disabilities (Foreman, 2005; Sailor, 1991). As such, inclusive

	education represents a whole-school concern and works to align special education with general education in a manner that most effectively and efficiently imparts quality education to all students" (Grima-Farrell et al., 2011, p. 118).
Equity	"Equity involves multiple concepts, including allocating resources; honoring and leveraging assets; and sustaining culture, as described in the following sections. [...] Equity is oftentimes defined as giving students the support they need to optimize their educational progress and maximize their potential, given historical exclusion and marginalization. [...] Equitable education also involves disrupting deficit perspectives and leveraging the strengths, cultural assets, and funds of knowledge (Moll, 2019) of students, families, groups, and communities" (Vetter et al., 2022, p. 5-6).

3.4.2 Target of educational goals

We can see different levels of goals that teachers' use of REDaK were supposed to achieve, namely at the student, teacher, school or system, and knowledge levels. The student level includes most of the expected 'end result' of the use of REDaK, that is, mostly indirect goals, such as improving student achievement, results, well-being, agency and so on. The teacher level includes more direct expected effects on the user of REDaK, such as increased skills, or more relational effects which are linked to student outcomes, such as improved teaching or better student support. The school or system level can be extended beyond the teacher using REDaK, and may for instance refer to the increase of collaboration among teachers or other educational professionals, as well as the change of educational systems and policies. The knowledge level encompasses goals indirectly linked to individuals, for instance creating new knowledge or research through the use of REDaK.

Table 9 below summarizes the different terms used in relation to educational goals according to each of the four levels described previously, and more examples can be found in the appendix 4.

Table 9.

Examples related to student-, teacher-, system- and knowledge-level goals.

Categories of goals reported	**Examples of student-related goals**
Social, emotional, and behavioral needs	"One ongoing challenge within education is preventing and responding effectively to problem behavior" (Mitchell et al., 2018, p. 1).
Academic outcomes	"help all students graduate from high school." (Penuel et al., 2020, p. 2).
Life outcomes	"improved the educational and life outcomes experienced by key stakeholders (e.g., practitioners, students, families)" (Vetter et al., 2022, p. 5).
Achievement and success	"foster achievement for all learners" (Grima-Farrell et al., 2011, p. 129).
Engagement	"shared goal, including [...] engaging students through active learning pedagogy" (Phelps, 2019, p. 10).
Learning	"adapting teaching and learning activities in order to address student needs and thereby maximize learning" (Hoogland et al., 2016, p. 378).
Equity, diversity and inclusion of students	"make the school and classroom environments, and curriculum and materials more responsive to students' backgrounds and learning needs, potentially reducing segregation based on performance levels or perceived abilities" (Grima-Farrell et al., 2011, p. 117).
	Examples of teacher-related goals
Learning environment	"Classroom management is widely acknowledged to be fundamental to effective teaching as it involves the actions taken by teachers to maintain safe and productive

	learning environments to maximise instructional time" (Hepburn & Beamish, 2019, p. 82).
Teaching, practice and instruction	"improve educational practice" (Rechsteiner et al., 2023, p. 2).
Diagnostic and formative evaluation	"identify the misconceptions students hold, and based on their PCK, they can determine how to alter their instruction accordingly" (Hoogland et al., 2016, p. 382).
Social justice teaching	"Thus, justice-oriented pedagogy focuses on teaching about power, oppression, and privilege and supporting others to make changes that promote equity (Bell, 1997; Hytten & Bettez, 2011; Sensoy & DiAngelo, 2017)" (Vetter et al., 2022, p. 7).
Teachers' professional development	"positive changes in teacher knowledge and practice" (Shelton et al., 2023, p. 58).
Teachers' reflexivity	"achieving harmony between what trainees have learnt from researching and the real social context, cognitively, affectively and self-efficaciously" (Wang et al., 2023, p. 12).
Teachers beliefs, dispositions and emotions	"practitioners have reported increased self-confidence and enthusiasm for their work and general improved feelings of community following network-related interaction" (Cooper et al., 2020, p. 11).
Teacher autonomy	"One of the biggest tensions inherent in educational knowledge brokering to support research use in practice is the potential conflict between short- and long-term goals, which may also be conceptualised as the tension between impact and teacher autonomy." (Rycroft-Smith, 2022, p. 35).
Collaboration	"engage in true genuine dialogue built on qualities such as humility, faith, and hope, and that ultimately gives voice and power to all parties involved. Voice and power can

	take many forms in a collaboration, including feeling legitimized by the collaboration, feeling joint ownership of the collaboration, and having an openness to being transformed by the collaboration" (Phelps, 2019, p. 12).
	Examples of system-related goals
School outcomes	"school performance" (Hemsley-Brown et Sharp, 2003, p. 452).
School and system improvement	"create substantive change in large scale systems" (Cooper et al., 2020, p. 6).
Educational professionals improvement	"improved the educational and life outcomes experienced by key stakeholders (e.g., practitioners, students, families)" (Vetter et al., 2022, p. 5).
Foster collaboration	"connect otherwise disconnected actors to facilitate staff interactions" (Rechsteiner et al., 2023, p. 21).
School and system equity, diversity and inclusion	"greater equity and distribution of power as goals" (Vetter et al., 2022, p. 18-19).
Facilitate change	"education faces the challenge of having to adapt in order to be more effective. Education needs to go through processes of enhanced individual and organisational learning and change. To ensure that this learning is continuous, it is important to build close links between research, policy and practice, through which relevant research can be made available at appropriate times for acquisition and use by practitioners and school organisations that have the potential to produce and share contextual knowledge" (Dagenais et al., 2012, p. 303).
System values	"replace traditional, liberal values with the values of 'what works', reflect on the dominant rules, schedules, or norms, disrupted long-standing power differentials between researchers and practitioners" (Vetter et al., 2022, p. 5).

	Examples of knowledge-related goals
Equity-oriented	”achieving a more democratised evidence system” (Sjölund et al., 2023, p. 1491).
Teacher-oriented	”design solutions to problems of practice while at the same time studying and improving these solutions” (Sjölund et al., 2023, p. 1492).
Knowledge-oriented	”producing new knowledge through the activity of knowledge brokering” (Rycroft-Smith, 2022, p. 38).

3.5 Conceptions of educational stakeholders’ professions, roles and interactions in relation to teachers’ use of REDaK

We have categorized the verbatims according to the underlying vision of the roles of teachers, researchers, system or other educational stakeholder and their collaboration in relation to teachers’ use of REDaK. In the quality use of research evidence framework from Rickinson and colleagues’ (2022), several features for quality use could be associated to the roles of different stakeholders in the use of REDaK. In particular, relationships, leadership, cultures, infrastructures and systems. We expanded that list based on the verbatims extracted from the articles. At the individual level, teachers’ skillsets and mindsets were the first two categories for which we found different visions conveyed through the language used. At the level between teachers and researchers, we included Relationships. At the systemic and structural levels, we included Leadership, Culture, Infrastructure and System-level influences.

Following the analysis of the verbatim extracted from the articles, we considered five axes of analysis concerning the conceptions of educational stakeholders’ professions, roles and interactions in relation to teachers’ use of REDaK. The first axis corresponds to the role of teachers and their profession. The second axis analyzes the roles taken by researchers. In the third axis, we unveil the relationships between teachers and researchers and link them to the roles taken within both professions. In the fourth axis, we focus more specifically on the role of brokerage and leadership in facilitating teachers’ use of REDak. Finally, in the fifth axis, we discuss the importance of culture, infrastructure and system-level influences for teachers’ use of REDaK.

3.5.1 Teachers' role and profession regarding the use of REDaK

We identified three main tensions related to teachers skills, mindset and agency. Regarding teachers' skills, on the one hand they are depicted as skilled and knowledgeable professionals (e.g., Shaik et al., 2018) while on the other hand, they are described as unprepared and lacking capacity (e.g., Shelton et al., 2023) or in need of professional development and training (e.g., Hepburn & Beamish, 2019). Regarding teachers' mindsets, authors such as Cain (2016) or Datnow and Hubbard (2016) stress the high variability of their attitudes towards REDaK, and it was overall less frequently addressed in the reviews. Regarding teachers' autonomy and agency, on the one hand, teachers are depicted as freely deciding whether to use REDaK (e.g., Merle et al., 2022) while on the other hand, they are described as required to use REDaK (e.g., Basckin et al., 2021).

3.5.2 Researchers' role and profession regarding teachers' use of REDaK

While teachers' roles were described in more depth than researchers' roles, we identified three main roles for researchers in relation to teachers' use of REDaK. First, researchers were described as producers of REDaK, for instance by producing research-based information (Dagenais et al., 2012) or datasets (Penuel et al., 2020) to be used by teachers, or to determine 'what works' (Sjölund et al., 2023) or effective practices (Basckin et al., 2021). Second, researchers were described as experts or "knowledgeable others" (Wei & Huang, 2022, p. 145) complementary to teachers' own expertise (Penuel et al., 2020). Third, researchers were described as playing a trainer, facilitator or overall supportive role for teachers. This ranged from the professional development training sessions provided by researchers (e.g., Datnow & Hubbard, 2016; Hepburn & Beamish, 2019; Mitchell et al., 2018) to supportive and encouraging behavior towards teachers (e.g., Grima-Farrell et al., 2011).

3.5.3 Relationships and role flexibility regarding teachers' use of REDaK

While we previously described teachers' and researchers' roles as fixed, we frequently found references to a more fluid, dynamic and evolving construction of each professional role. For instance, the production of REDaK was not only described as the sole responsibility of researchers: teachers may also contribute to such production (e.g., Jones et al., 2022; Sjölund et al., 2022, 2023; Wang et al., 2023). Some researchers explicitly mentioned the importance of revising traditional roles. For instance, Cooper and colleagues (2020) mentioned that "making effective

use of strategic roles often requires the evolution of traditional roles or the creation of new roles altogether" (id., p. 8). Likewise, Sjölund and colleagues (2023) criticized the "binary division of roles (researchers and practitioners) [which] may not fully capture the complex organisations in which both systems operate" (id., p. 1504) which echoes Jones and colleagues' (2022) suggestion that "new combined forms, or hybrids of the roles of researcher and teacher might offer significant potential for challenging and changing the research-teaching binary in education." (id., p. 8).

The importance of the relationships between teachers and researchers was widely shared, first of all through collaboration (Gerzon, 2015; Goddard et al., 2022; Grima-Farrell et al., 2011; Wang et al., 2023; Wei & Huang, 2022). Communication, dialogue, interactions, role negotiation and clarification were all advocated for to various extents. The main idea was that both groups of professionals may have different perspectives, but that each could make a move towards the other group in order to overcome "perception gaps" (Pereira & Fang, 2022, p. 158) or power relationships (Phelps, 2019).

3.5.4 Brokerage and leadership to facilitate teachers' use of REDaK

While collaboration across teaching and research professions was often mentioned, other forms of collaboration among teachers or other educational stakeholders were also suggested (e.g., Datnow & Hubbard, 2016; Gerzon, 2015; Goddard et al., 2022; Rechsteiner et al., 2023). Two reviews focused on brokerage (Rechsteiner et al., 2023; Rycroft-Smith, 2022), describing the extent to which some educational stakeholders, sometimes teachers or researchers themselves, but also other professionals such as principals, could "act as intermediaries" (Rechsteiner et al., 2023, p. 23) or "cultivate relationships between members of research and practice organisations to facilitate research production and use" (Sjölund et al., 2023, p. 1493).

Beyond brokerage, which requires specific skills and knowledge of both research and teaching environments, leadership within schools has emerged as one of the important facilitators of teachers' use of REDaK. Leaders "have the responsibility to create an organisational culture and structure in which research knowledge could connect to teacher knowledge (e.g. Brown & Zhang, 2016), to work actively for the establishment of a positive ethos in collaboration, and to provide the necessary resources and support" (Schaik et al., 2018, p. 58). Their role appears to be

primordial for the sustainability of teachers' use of REDaK (e.g., Wei & Huang, 2022).

Leadership also seems connected to the last dimension of culture, infrastructure and system-level influences, as leaders are supposed to foster a culture of the use of REDaK among teachers (e.g., Hemsley-Brown & Sharp, 2003), to allocate resources for the use of REDaK (e.g., Hoogland et al., 2016; Merle et al., 2022; Schaik et al., 2018) or to buffer systemic pressures susceptible to limit teachers' use of REDaK (e.g., Rechsteiner et al., 2023).

3.5.5 Cultures, infrastructures and systems influencing teachers' use of REDaK

The organizational level has been reported as decisive for teachers' use of REDaK. Beyond individual teachers' motivations for the use of REDaK, the school's and educational system's culture as well as opportunities of constraints for the use of REDaK arguably shape most of the actual practices. These elements are related to all previously described roles: teachers as well as researchers are professionals working within institutions. Those institutions have rules, norms, and protocols which may facilitate or hinder skill and expertise building, collaboration and positive relationships across professions, meaningful leadership and support for all.

The example found in Wei and Huang (2022) focusing on Asian contexts illustrates well how different cultures may influence teachers' use of REDaK. The various frameworks to describe teachers' use of REDaK address to different extents the infrastructure and systemic dimensions of teachers' use of REDaK, contrasting "small-scale collaboration on an individual basis [with] structural collaboration between schools and research institutes" (Schaik et al., 2018, p. 57). While the former may be easier to create and study, many reviews stressed the need for "state- and district- level supports, as well as collaborative partnerships with universities" (Mitchell et al., 2018, p. 11) to sustain the use of REDaK.

3.6 Links between REDaK, their use, the goals and professionals involved

We connected the findings related to researchers' use of concepts describing the use of REDaK with the vocabulary chosen to describe the goals for the use of REDaK by teachers as well as the roles and structures involved. This resulted in the four archetypes, or simplified patterns of what the use of REDaK could entail, described below. These archetypes do not aim at classifying each article in one

category or another, as the complex reality often leaves some ambiguity and inconsistencies within a single review.

3.6.1 The use of REDaK as top-down and rigid

This archetype of the use of REDaK is characterized by the use of a language in which school and student outcomes are the key goals, through teachers' improvement. REDaK is judged of quality when it is at first and foremost objective and generalizable, valued for the rigor of its production process associated with scientific and quantitative methods. The use of REDaK is judged of quality based on the fidelity of implementation of interventions which have proven their effectiveness, and the sustained instrumental use associated with a wider dissemination are central. Teachers and researchers represent two distinct communities, with fixed roles: researchers should produce REDaK and train teachers who can then apply the best practices. The system and infrastructures should provide teachers with the capacity to improve their teaching so that they can help students succeed.

This archetype for the use of REDaK may be associated with evidence-based practice.

3.6.2 The use of REDaK as opportunistic means for teaching and learning progress

This archetype of the use of REDaK is characterized by the use of a language in which student learning as well as teaching improvement are the key goals. REDaK is judged of quality when it is at first and foremost accessible and useful. The use of REDaK is judged of quality based on the successful articulation of conceptual and instrumental use. Researchers remain the experts while teachers are seen as in need of training, with fixed roles for both, and their relationship is not necessarily horizontal. Their collaboration is mostly driven by a genuine question of effectiveness of teaching practice improvement. The system and infrastructures set the rules and constrain the use of REDaK, but are also full of opportunities which can be seized without changing the system itself.

This archetype for the use of REDaK may be associated with research use.

3.6.3 The use of REDaK as collaborative self-improvement means

This archetype of the use of REDaK is characterized by the use of a language in which improving teaching through collaborative efforts is key. REDaK is judged of

quality when it is first and foremost appropriate, comes in an easy to use format, and is timely. The use of REDaK is judged of quality based on the recognition and articulation of problems and sense making. Teachers and researchers are mostly disconnected, as teachers are seen as continuously learning professionals who can make sense of REDaK, and at the margin researchers may be trainers or experts supporting their learning. The system and infrastructures are of major importance to facilitate the time and resources necessary for teachers' sensemaking of REDaK. The development of a culture with appropriate leadership is crucial for the success of teachers' use of REDaK.

This archetype for the use of REDaK may be associated with data use.

3.6.4 The use of REDaK as empowering and emancipatory

This archetype of the use of REDaK is characterized by the use of a language in which social justice teaching and equity-oriented knowledge creation as well as facilitating change and questioning the system values are the key goals. REDaK is judged of quality when it is first and foremost relevant or worthwhile for teachers or practice-informed. The use of REDaK is judged of quality based on the depth of investigation addressing issues of power and equity and being mutualistic and horizontal in their process. Teachers and researchers thus have flexible roles, working together and adapting to each others' culture and professional needs. They are both seen as experts, able to produce meaningful REDaK. The system and infrastructures is itself questioned and criticized as it should provide resources to sustain the fruitful, collaborative interactions between teachers and researchers while avoiding to create power imbalances among the educational stakeholders involved.

This archetype for the use of REDaK may be associated with research-practice partnerships.

4. Discussion

We have conducted a systematic review of previously published reviews in the field of K-12 general teachers' use of research, evidence, data or knowledge (REDaK). We have included a broad range of concepts referring to sources of information that teachers could use to achieve an equally broad range of educational goals. This openness made possible the comparison of various frameworks for teachers' use of REDaK which have not previously been compared. The step back taken by doing a systematic review of reviews gave us the global perspective of the field, confirming

the contested status of the definitions of key concepts such as 'research' or 'research use' (Rycroft-Smith, 2022), as well as the contested status of teachers as professionals (Tatto, 2021a). In addition, we shed light on the frequent misreporting of the definition of REDaK, its use, the goals for teachers' use of REDaK and the respective roles of educational professionals in teachers' use of REDaK. We also found concepts across different conceptions of teachers' use of REDaK, for instance *sensemaking* (Goffin et al., 2022), which we believe could contribute to clarify the similarities and differences across these conceptions.

We asked one research question per level of interest related to teachers' use of REDaK (what is REDaK, what is *using* REDaK, for which purpose using REDaK, and what are the roles of stakeholders in teachers use of REDaK), and the last question addressed the link between those dimensions. In the following, we will discuss how we answered these questions and the possible implications for future research and practice.

4.1 Conception of REDaK to be used by teachers

The first unsurprising-yet-disappointing finding of this review is the lack of explicit definition of the REDaK in more than half of the studies. In addition, there appears to be a frequent overlap of terms used to characterize REDaK across these reviews, but these terms often remain ambiguous. 'Validity' of REDaK, for instance, was frequently cited, but depending on the epistemological framework of the authors, the validity of REDaK may not be assessed based on the same criteria. In addition, different research methods employed may foster different kinds of validity.

In order to improve this conceptual clarity, we have built upon the reviews to create categories of quality features of REDaK. However we share the criticisms related to the ambiguity and lack of consensus over definitions, as well as possible problematic consequences of ignoring underlying problems. Rycroft-Smith (2022), for instance, reminds us that "the use of the terms 'rigour' and 'objectivity' when applied to research should always be regarded with suspicion. Research is never neutral or objective (Swann & Pratt, 2004) and always contains embedded values at every stage, including choice of doing that particular research in the first place" (id., p. 40). Goffin and colleagues (2022) similarly warn readers about data: "different types of data have different 'modal affordances' [...] Awareness of these modal affordances—the way specific types of data become associated with specific beliefs and practices—offers a way of looking at why certain data are

overemphasised or accepted as valuable and valid" (id., p. 24-25). Our choice of categorization is likewise not neutral and reflects to some extent the understanding of the authors of the current paper. We thus encourage readers to critically judge them, and to re-contextualize them when they appear in scientific articles.

4.2 Conceptions of teachers' use of REDaK

Despite the central dimension of the concept of teachers' use of REDaK in the reviews included in our study, many reviews did not explicitly define what they meant by use of REDaK. The large number of terms more or less closely related to teachers' use of REDaK illustrates well the blurriness of the field. By listing the different concepts of teachers' use of REDaK and linking them with features illustrating when the use of REDaK was of quality, we hopefully contributed to shed light on some implicit characterizations of the use of REDaK.

Despite differences in theoretical frameworks, the vocabulary used among the reviews did overlap quite often, while the features to consider that the use of REDaK was of quality differed significantly. We identified patterns emerging across reviews in terms of vocabulary used, and we built upon the existing literature to categorize those patterns. More specifically, we suggest further expansion of Doucet's (2019) expansion of Weiss and Bucuvalas' (1980) typology of research use. We expanded this typology by adding to the instrumental, conceptual, symbolic, imposed and process use typology, a new category of use called *relational use*. Relational use could be defined as a focus on the interpersonal and structural dimension of use of REDaK. For instance, organizing a journal club in which teachers meet to discuss a research article they read, the relational dimension of this setting is central. Likewise, data-based decision-making could focus on relational use if the social context for discussing and analyzing data is central. Using this model allowed us to show that reviews never referred to anything close to symbolic use of REDaK, and very few included elements which could refer to imposed use.

4.3 Conceptions of educational goals that the use of REDaK intends to help teachers achieve

The various goals for teachers' use of REDaK were rarely specified in the reviews included in our study, probably because the role of reviews was mainly to summarize a large variety of studies, all of which may have different educational

focus. Indeed, the vast majority of reviews included did not define any explicit goal for teachers' use of REDaK. Our study revealed that such goal definition is a blind spot in our research fields, and that it should be addressed in future work on the topic.

We found a large number of implicit references to educational goals, with vocabulary focusing on student-, teacher-, system- or knowledge-related goals. However, most of the recurrent terms used were vague. We encourage researchers to avoid as much as possible pre-digested sentences such as 'improve teaching' or 'foster achievement' because they do not allow us to understand what exactly is meant. We are all in favor of 'good education', but we may disagree with the way it is defined. It is uncomfortable to look at our blind spots, but the only way to overcome structural problems of power inequalities in research is by being honest and transparents, as well as welcoming new voices who will shake up the status quo of research being traditionally led by western, old, white, very educated, rich men (Tseng, 2022).

4.4 Conceptions of educational stakeholders' professions, roles and interactions in relation to teachers' use of REDaK

In line with Rickinson and colleagues' framework of quality use of research evidence (2022) as well as much research conducted in the past decade, it appears clear from our review that many contextual and structural elements shape teachers' use of REDaK. Our results expanded this understanding by identifying various roles for teachers and researchers, but also other educational stakeholders regarding teachers' use of REDaK.

Our first category related to teachers' profession stressed tensions regarding their skills, mindset and agency: are they skilled, willing and autonomous professionals ready for REDaK use, or unprepared, lacking capacity and in need of training ? Our second category showed that researchers were mainly seen as producers of REDaK as well as experts or "knowledgeable others" (Wei & Huang, 2022, p. 145). But it appears clear that what is often called boundary crossing in the field of brokerage (e.g. Rycroft-Smith, 2022) was important to consider, which we included in our third category about relationships and role flexibility. Many articles reviewed, for instance Sjölund and colleagues' (2023) review, stressed the importance of an evolution of traditional role, or the creation of new roles (Jones et al., 2022). Among the new roles, brokers could increasingly become part of the educational and research institutions (Malin & Brown, 2019; Neal et al., 2022). Every educational

stakeholder in a position of leadership could be a privileged interlocutor either to become a broker, or to facilitate brokerage within the institutions. We grouped brokerage and leadership in a single category with the idea thay they represented key enabling factors for facilitating sustained teachers' use of REDaK (Wei & Huang, 2022). Our last category was dedicated to the more global influence of cultures, infrastructures and systems, playing a major role in teachers' use of REDaK in practice (Rickinson et al., 2022).

A change of culture, along with a change of institutions, seems necessary to large-scale, long-term changes in teachers' and researchers' professions. This appears necessary if we want to see meaningful use of REDaK by teachers, in the sense that it helps teachers, researchers, and other educational stakeholders co-define the goals and work collaboratively towards their achievement. All changes discussed here are highly political-dependent: infrastructural changes are beyond the scope of this paper, but we believe that there is a democratic stake to be seized by educational stakeholders altogether.

4.5 Links between REDaK, their use, the goals and professionals involved

Our work allowed us to identify four archetypes of teachers' use of REDaK, linking the concepts used with particular educational goals and with a particular vision of the roles and structural elements involved.. While in practice not any single framework perfectly fits the archetypes, we believe that it is important to use them in order to reflect about where we stand as researchers, and what the consequences of our positioning may be.

For instance, the '*top-down and rigid*' archetype may seem caricatural, as it reflects a vision of teachers' use of REDaK that even proponents of the evidence-based education movement may not judge as desirable. However, its roots go beyond social desirability, and the vocabulary used reflects an ideology that has consequences for our society. Furthermore, it seems counterproductive for teachers' use of REDaK: focusing on teachers' implementation of research results without encouraging them to be critical producers and readers of research emphasizes short-term instead of long-term, more beneficial approaches (Rycroft-Smith, 2022). The *opportunistic* archetype, which is characterized by its oriented collaboration between teachers and researchers, already suggests what evidence-based education has been moving towards, that is not a top-down approach to research use, but rather finding 'what works' so that teachers improve

their practices – without much reflection on what 'improving their practices' means, and whether we should question it.

The frameworks for teachers' data-based decision making which inspired the *collaborative self-improvement of teaching* archetype is peculiar in that it seems to require no, or little, collaboration with researchers. As such, it may be structurally more realistic to aim for than the *empowering and emancipatory* archetype of teachers' use of REDaK, which is more focused on role and structure critique. Despite many challenges to large-scale data-use by teachers, it seems to be a step forward to teachers' professional autonomy with local as well as larger data use, and may lead to collaboration across many educational stakeholders. While the empowering and emancipatory archetype of teachers' use of REDaK is probably more resource consuming, it may also end up being the most interesting in the long run if we want to avoid locally patching problems, but actually addressing them altogether.

4.6 Implications

Teachers' use of REDaK starts with an understanding of what REDaK is, why it is possibly valuable, and what could make it more useful. It is directly affected with the understanding and planning of what the process of such use is, or can be, and it cannot be reasonably separated from underlying educational goals for such use. Finally, the complexity of teachers' use of REDaK makes it extremely important to study it within a system, and not just depending on the willingness of some specific individuals. We thus encourage every researcher, especially those doing literature reviews in the field of teachers' use of REDaK, to uncover as many ambiguities and blurriness as possible, so that hidden power struggles can be directly addressed.

Our review of reviews provides a much needed cartography of terms and concepts used, also revealing what is missing in most published papers. We hope this will help researchers, reviewers and editors to improve and clarify the positioning of future research work in the fields of teachers' use of REDaK. We also believe that the list of words to characterize REDaK, the process of their use, as well as the goals, can be used as the basis for larger-scale lexicographic analyses. These analyses could provide a complementary assessment of whether the lack of clarity in the reviews within our scholarly field are also present in more traditional empirical and theoretical papers. The categories of important concepts we suggested can also help future research in using comparable vocabulary across

different, but similar and partially overlapping fields (e.g., data-use and research-practice partnerships).

Finally, even though as a review of reviews our work may be very abstract and theoretical as compared to the practical needs of teachers and other educational stakeholders, we believe that the clarifications we ask researchers to make can have practical benefits for other educational stakeholders. In particular, we believe that future research-practice partnerships could benefit greatly from having common norms set with a vocabulary inspired from the findings of our review. By positioning themselves according to our categories of REDaK, the use of REDaK, goals for such use and relationships among actors and system-level elements, we believe that teachers, researchers, leaders and decision-makers can work together with less friction and better mutual understanding.

4.7 Limitations

A first limitation is relative to the scope of our review. There is a tension between the breadth and depth of the review which we tried to balance as best as possible. On the one hand, our review is large because of the variety of frameworks concerning the use of REDaK by teachers which we included. We opened the scope, usually restricted to teachers' use of research and evidence, by including data and other forms of knowledge. On the other hand, our review may lack depth because most of the frameworks under scrutiny were represented by a low number of articles included. Because of time constraints, we limited the number of articles with the choice of eligibility criteria which may have made us miss important studies in this field. By focusing on peer-reviewed reviews that gave an explicit explanation of the method used, we missed not only all original publications but also many reviews either not published, not peer-reviewed, or simply not clear enough to reach the threshold of our inclusion criteria. If most reviews included in our systematic review were published recently, it may be due to the global improvement in scientific reporting of methods used in the past decades. For instance, Brodbelt (1986) or Schwanke (1981) produced reviews which addressed the topic of teachers' use of research and, as such, might have been included, but their lack of explicit method for the review led to their exclusion. A more open complement to our review could broaden the inclusion criteria so as to allow for studies lacking methodological clarity to be included in the review, and it would be interesting to see whether our conclusions still hold.

A second limitation is that the search equations were limited to some vocabulary we knew could refer to teachers' use of REDaK. For instance, we did not include the term "information" as part of the REDaK, or we did not include terms such as sensemaking which turned out to be the major focus of one review and mentioned in several others. In addition, we had to twist our search equation to include the review on knowledge brokering by Rycroft-Smith (2022) because neither title nor abstract originally matched, despite her review being a cornerstone of the field. The focus of brokerage being slightly different from teachers' use of REDaK coupled with different vocabulary could suggest a challenge to include this research field in our review, and that we found only 2 reviews on brokerage to include in our research. It is thus difficult to know to what extent the differences found in terms of number of reviews sorted by major concepts regarding the use of REDaK is due to our search procedure or the actual imbalance within this research field. Future reviews may build on our findings to broaden the search equations and use a snowball approach to research saturation of the concepts related to teachers' use of REDaK.

A third limitation is the possible discrepancy between the reviews and original articles in a given field of research. By focusing on reviews, arguably leading the field and being cited more than other articles (Montori et al., 2003; Royle et al., 2013), we do not know to what extent we can generalize the results to all fields of teachers' use of REDaK. Lexicometric analyses of primary research in the fields of teachers' use of REDaK could be used to compensate for this limitation by using as a starting point the concepts extracted from our open coding.

A fourth limitation is that we did include only to a limited extent the scientific literature on teachers' production of REDaK. Indeed, much literature has stressed the link between teachers' use and production of REDaK. However, by focusing on teachers' use of REDaK, we have certainly missed many articles articulating teachers' use and production of REDaK. A future expansion of our research could try to include the different methodological approaches linking production and use of REDaK beyond research-practice partnerships, but also searching, for instance, the research around teacher research (Cochran-Smith & Lytle, 2015). The review conducted by Sjölund and colleagues (2022) about the use of research within research-practice partnerships and that of Penuel and colleagues (2020) on data and evidence use as part of research-practice partnerships illustrates well this interest to link production and use of REDaK to be develop further.

4.8 Suggestions for future research and practice

The fields of teachers' use of REDaK have been growing exponentially in the past decade, as could be seen through the very high number of reviews published in the previous years as compared to 2015 and before. While our review wasn't focused on the facilitation of teachers' use of REDaK, a large number of the reviews included in our review mentioned elements to facilitate teachers' use of REDaK (e.g., Dagenais et al., 2012). Therefore, we could see a few increasingly consensual elements which we want to stress, both to inform future research in the field as well as to contribute to improving future practice, while leaving the definition of what counts as 'improvement' to the educational stakeholders involved themselves.

First, top-down, one-way flow of knowledge is seen as problematic and ineffective. We position our work in line with critical epistemologies and social justice oriented research, and as such, we believe that there is a need for a more democratized system of evidence in education, as do some authors whose work we reviewed (Pereira & Fang, 2022; Rycroft-Smith, 2022; Sjölund, 2022, 2023). However, even without such an orientation, it appears that it is simply more effective to embrace a more horizontal view of teachers' use of REDaK. Considering teachers as skilled professionals and viewing their collaboration with researchers as a two-way street (Tseng, 2017) is likely to improve the one-way, research-to-practice orientation of many evidence-based educational research. Considerations regarding the leadership, infrastructures and system-level dimensions are inevitable and necessary to increase the chances of any achievement towards teachers' use of REDaK. The implication of teachers in the very production and management of REDaK, given proper structural conditions, has been stressed as very promising in terms of facilitating teachers' use of REDaK as well as ethically and politically compatible with a critical orientation increasingly advocated (e.g., Doucet, 2019; Gitomer & Crouse, 2019; Tseng, 2022).

As such, we suggest the meta-framework below which can be used as part of research-practice partnerships with teachers and researchers, but also as part of data use support for teachers without interactions with researchers, to "solve wicked problems in education" (Rycroft-Smith, 2022, p. 24).

4.9 The Teachers as Researchers program as a meta-framework to facilitate teachers' use of REDaK

The 'Teachers as Researchers (TaR) program has been described in more detail by Atal and colleagues (2022), but we will outline it and share recent additions relevant to facilitating teachers' use of REDaK. This program is inspired by teacher research and professional learning communities, and aims to create communities of educators which 1) document educational challenges they face, 2) describe actions to overcome those challenges, 3) collect relevant data from schools prior to, during and possibly after implementation of the action and 4) share structured feedback, or research reports including a contextualized analysis of the effect of the action in relation to the challenge.

Firstly, the TaR program is based on open-source templates to guide educators in all steps of their teaching research process. Secondly, the framework is based on a community basis work, which means that educational stakeholders may join a community because they are interested in a given topic treated by a specific community (e.g., teaching critical thinking) or because a community has been created in their school (without a pre-specified topic of interest). Thirdly, the process of the TaR program includes activities to link research with practice on a voluntary basis: the open-source templates suggest the addition of sources throughout the description of challenges and actions for instance, but there are also guidelines for teachers to find, read and make the most out of research resources for their own teaching research. In addition, suggestions for contacting researchers are provided to teachers because, in many cases, teachers who may not have time to find and read research may benefit more from a quick interaction with a researcher who is an expert on the topic of interest. Similarly, researchers may use this opportunity to connect with motivated teachers who contribute to doing research on their field of interest. All work done by communities is mutualised and published in a dedicated open collaborative platform.

Sjölund and colleagues (2022) suggested different types of partnerships in which research could be used to inform the intervention method or content. They outline three families of research methodologies related to three types of research practice-partnerships: (1) inquiry methodologies related to research alliances; (2) design methodologies related to design research; and (3) improvement science methodologies related to networked improvement communities. In the first family, the opportunities for teachers' use of research may be primarily conceptual, in the

second family, primarily instrumental, and in the third family, primarily processual. We believe that the TaR program can be considered as a meta-framework because it can support the facilitation of these three types of use of REDaK by teachers (Jeune et al., chapter 3).

Beyond research-practice partnerships, this meta-framework may also work for teachers and other educational professionals without researchers, as a relevant framework for data collection and use, including sensemaking. Brokers may use this framework by playing the role of community facilitators, and inviting a diversity of educational stakeholders (teachers and researchers, but also possibly parents, students, and so forth). As such, this framework may help different stakeholders explicitly co-construct their wished educational goals.

While the TaR program appears promising in relation to the literature reviewed on facilitating teachers' use of REDaK, it is important to keep in mind that it is resource intensive, and as such required adapted infrastructures, and thus probably funding to sustain its large-scale use. It may represent a considerable change of culture for many educational systems as it blurs the roles of teachers and researchers, which means they may have to learn from each other's expertise, develop new skills. It may also require leadership, training and coaching, or diverse facilitation actions so that educational stakeholders become familiar with this framework or any similar framework it could inspire.

Given appropriate resources within a system supporting the use of such a framework, researchers could on their end increasingly focus on justice, equity and power relationships as we believe is needed.

Chapter 3: One resource to help them all. A design-based research to facilitate teachers' use of research on teaching critical thinking.

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Abstract

Various frameworks to facilitate teachers' use of research have been developed, but these have not been widely applied in the field of teaching critical thinking. Developing students' critical thinking is recognized globally as a crucial educational goal, yet teachers often lack the necessary training and support. Collaborative frameworks, such as research-practice partnerships, brokerage, or design-based research, could be pivotal in creating resources and networks dedicated to facilitating teachers' use of research on teaching critical thinking. We conducted a design-based research study to co-create a research-brokered resource on teaching critical thinking, and created a network of teachers that built upon and contributed to this resource. Over 30 researchers and teachers participated in various stages of the project, which included reviewing a previous research-based (but not brokered) resource on teaching critical thinking, participating in meetings to prioritize suggested changes to that resource, and engaging in online workshops as part of the network dedicated to teaching critical thinking. The review of the initial resource indicated the need for improvements to better adapt it to the target audience of teachers and to include elements that facilitate teachers' conceptual and instrumental use of research on teaching critical thinking. Our results suggest that the new resource successfully incorporated these elements and was effectively linked to challenges on teaching critical thinking and actions to address them identified by the network. The network contributed to the resource with concrete examples, while the resource, in turn, enriched the network's descriptions of challenges and actions, demonstrating a successful, two-way relationship. Future research should evaluate the effect of using the resource and network as part of a teacher training program aimed at facilitating teachers' use of research on teaching critical thinking.

Research in the field of teachers' use of research has long focused on finding ways to improve such use with more recent attention to address issues of power and equity between teachers and researchers (Doucet, 2019; Jeune et al., chapter 2; Tseng, 2022; Vetter et al., 2022). Our work focuses on the contribution of research in helping teachers solve educational challenges related to the development of students' critical thinking, which has been recognised by both researchers and institutions as particularly important (e.g. Fuchs-Gallezot & Bächtold, 2023). In the field of teaching critical thinking, the reflection on the need to integrate power and equity issues is central in Freire's (2018) critical pedagogy. It has however been left aside in many epistemological-centered (e.g., focusing on true/false statements) visions of critical thinking (e.g., Pasquinelli & Richard, 2023). The integration of the reflection on ethical and political issues in teaching critical thinking is nevertheless present in recent work (e.g., Gagnon, 2020). In line with such approaches, our work aims at integrating diverse voices related to both teachers' use of research and teaching critical thinking. To achieve this aim, we provide both teachers and researchers with opportunities to produce research and knowledge which can be useful for other teachers.

We first review the scientific literature describing some collaborative frameworks adapted to facilitate teachers' use and production of research. We then discuss the literature on resources for teaching, and more specifically about teaching critical thinking. Finally, we present our study aiming at the co-creation of a research-based resource and a network dedicated to teaching critical thinking through a design-based research approach.

1.1 Collaborative frameworks to link teachers' use and production of research

The idea to guide teaching according to 'best practices' or 'what works' has driven much of the educational changes of the past few decades in line with the evidence-based educational movement (Pellegrini & Vivanet, 2020). However, many hopes raised by evidence-based education proponents were not met, as simple dissemination of research findings to teachers did not improve teaching practices (Gorard et al., 2020). In addition, many debates raged among scholars regarding epistemological and political orientations of various approaches to teachers' use of research. Biesta (2010) claimed that questioning the effectiveness of teaching will always come second to values-laden choices regarding what counts as 'good education'. As such, research methods focusing on measuring effectiveness

without acknowledging the underlying goals and values behind the measurement tools or without contributing to theory are prone to critique and have problematic side effects (e.g., Burnett & Coldwell, 2021).

Beyond naïve approaches to evidence-based education, the field has now evolved and there are a variety of research approaches to improve teaching practices. Evidence-based proponents have increasingly invited teachers to collaborate in the design of interventions (e.g., Bressoux, 2020). Collaboration between teachers and researchers is considered as a promising way to facilitate teachers' adoption or implementation of research-informed practices (Gorard et al., 2020). But this vision, described by Jeune and colleagues (chapter 2, p. 78) as "opportunistic means for teaching and learning progress", is still problematic because power imbalances remain (Vetter et al., 2022). In her essay, Tseng (2022) gives an overview of the evolution of the research field studying teachers' use of research: initially, research had focused on describing actual research use by teachers (and lack thereof); then, research focused on intervention studies and understanding how to improve teachers' use of research. Now, she argues in line with recent research (Doucet, 2019; Rudolph et al., 2024) that research use is embedded in power struggles, and that as we live in an oppressive society for many minorities, it is important to use critical lenses to study to whom research use may benefit. As most research on research use is conducted by researchers in WEIRD (Western, Educated, Industrialized, Rich and Democratic) countries, and that researchers themselves are often privileged, they may not be best suited to address power inequalities through research use. Hence the need for more critical research, changing the status quo of evidence based education.

We describe here some promising frameworks for teachers use of research with values consistent with an emancipatory and empowering vision of the teaching profession as well as with social justice orientations of teachers' use of research: research-practice partnerships (Coburn et al., 2013; Sjölund et al., 2023), brokerage (Rechsteiner et al., 2023; Rycroft-Smith, 2022) and design-based research (Anderson & Shattuck, 2012; Sanchez & Monod-Ansaldi, 2015).

1.1.1 Research-practice partnerships

Research-practice partnerships have mainly developed in the United States with the definition of Coburn and colleagues (2013) as the usual reference: partnerships being long-term; addressing problems of practice; mutualistic (i.e., benefiting both

teachers and researchers); using intentional strategies to feed the relation between teachers and researchers; and producing original analyses.

Research-practice partnerships are promising to facilitate teachers' use of research because of a number of qualities. For instance, teachers' participation to the production of new research contributes to their familiarity with research methods and mechanisms – or what Doucet (2019) qualifies as process use of research, as a complement to Weiss and Bucuvalas' (1980) instrumental use of research (e.g., changing one's teaching practices based on research results), conceptual use of research (e.g., changing one's ideas about teaching, or ways to understand a problem), or symbolic use of research (e.g., justify one's already-made educational decision by referring to research). In addition, these partnerships are usually built with institutional support and infrastructures which are key to facilitate a use of research of high quality (Jeune et al., chapter 2; Rickinson et al., 2022). This means that teachers may benefit from allocated time, training or support to constructively interact with researchers and collaborate with each other.

The literature review by Sjölund and colleagues (2023) identified different categories of research-practice partnerships with different focus and roles among partners. For instance, inquiry partnerships focus on the collaborative investigation and documentation of teaching problems. The collaboration between teachers may range from a more or less active and expert role of teachers, who may contribute more or less to the data collection and analysis. They also identified design partnerships in which the focus is to design a solution to a teaching problem and not simply build knowledge on the problem. Again, teachers and researchers may complement each other with different degrees of implication. The last type of partnership focuses on dissemination, and involves teachers and researchers with the idea to share knowledge and expertise.

In another review, Sjölund and colleagues (2022) suggested that there exists three types of research-practice partnerships associated with three types of research frameworks which can also be linked to some partnerships listed previously: inquiry (e.g., research alliances), design (e.g., design-based research) and improvement science (e.g., Bryk's (2015) networked improvement communities). They associate some of the models to different types of use of research cited previously: inquiry is most associated with conceptual use of research, whereas design is primarily associated with instrumental use of research, and improvement science is mainly associated with process use of research.

These different modelizations of research-practice partnerships accurately remind the importance of clarifying the goals for teachers' use of research in order to choose the appropriate format. It is especially true in relation to two other fields, each of which being more or less connected to different types of research-practice partnerships: brokerage (Rechsteiner et al., 2023; Rycroft-Smith, 2022) and design-based research (Anderson & Shattuck, 2012; Sanchez & Monod-Ansaldi, 2015).

1.1.2 Brokerage

Two recent reviews focusing on brokerage (Rechsteiner et al., 2023) or knowledge brokering and knowledge mobilisation (Rycroft-Smith, 2022) have pointed out that the definitions of brokerage, knowledge brokering, brokers and other similar terms are far from consensual. Rechsteiner and colleagues (2023) first stressed that brokers refer to individuals or organizations who do brokering activities, which Rycroft-Smith (2022) suggests as including the idea of a flow of knowledge across communities as well as the connection between those communities. Brokerage, which Rechsteiner and colleagues (2023) consider as the appropriate term when brokers and brokering are involved or put in relation, can take many forms depending on the framework considered. In the four families of frameworks they describe, brokers and brokerage play slightly different roles. Brokers may focus on connecting otherwise disconnected people, transferring knowledge, translating and coordinating different groups working together on boundary objects so that they can learn from each other, and playing the role of leaders to connect subteams within a school. Brokerage ranges from a very social, relation-oriented set of activities to a more knowledge-oriented set of activities, both being always included to various extents.

Research-practice partnerships can benefit from the participation of brokers (Cooper et al., 2020; Sjölund et al., 2023) to facilitate teachers' use of research. In these partnerships, brokers may be either teachers, researchers, or different professionals with a good knowledge of both teaching and research. They may play an important role in creating a common culture and build meaningful relationships across the actors involved. In the context of research-practice partnerships with a dissemination aim, that is, making sure that the knowledge co-created by teachers and researchers can be useful for others, the notion of brokered knowledge is interesting (Rycroft-Smith, 2022). Rycroft-Smith (2022) argues that brokers may contribute to the creation of a new type of knowledge – brokered knowledge – by

transforming research knowledge into a different format, with a more accessible language, by clarifying the possible teaching implications or by rescaling the contents. Jeune and colleagues (2024) have similarly found that different educational stakeholders all tend to agree that research presented in an appropriate manner for an audience of teachers, and which contains elements aiming at facilitating a conceptual or instrumental use of research would positively influence teachers' use of such research. Therefore, brokerage as part of a research-practice partnership may contribute to the co-creation of new, brokered knowledge made appropriate to facilitate teachers' use of research. One way to do this in practice is through the use of a design-based research approach.

1.1.3 Design-based research

The models of research-practice partnerships described by Sjölund and colleagues (2023) as well as the various frameworks for brokerage described by Rechsteiner and colleagues (2023) show that several collaborative research methods may be used to facilitate teachers' use and production of research. With a historical perspective on the collaborative research methodologies, Sanchez and Monod-Ansaldi (2015) described design-based research as aiming both to solve problems faced by teachers and contributing to producing original knowledge. Anderson & Shattuck (2012) define quality design-based research as "Being Situated in a Real Educational Context [...] Focusing on the Design and Testing of a Significant Intervention [...] Using Mixed Methods [...] Involving Multiple Iterations [...] Involving a Collaborative Partnership Between Researchers and Practitioners [...] [has evolving] Design Principles" (p. 16-17)

We thus believe that design-based research methods may be adapted to co-create brokered knowledge through the involvement of researchers and teachers. On the one hand, this brokered knowledge could be useful to improve teachers' practice according to their own educational goals, thus providing a more democratically relevant knowledge base (Pereira & Fang, 2022; Rycroft-Smith, 2022; Sjölund, 2022, 2023). On the other hand, this brokered knowledge could be useful to contribute to researchers' theory, fed by teachers' contributions in the collaborative generation and analysis of data.

The criteria from Nieveen and Folmer (2013) to evaluate the quality of design-based research projects are their relevance, validity, consistency, practicality and effectiveness. In addition Mandran and colleagues (2022) described principles of design-based research in relation to different categories of the research activity,

which, in the case of the co-creation of brokered knowledge, correspond to organize research, include teachers, produce and analyze data, document the process and balance the local goal vs. global goal. One core principle of design-based research is its iterative dimension, with frequent involvement of teachers at the different stages of the iteration.

While, in theory, design-based research seem to be adapted to co-create meaningful and democratically generated knowledge useful for both teachers and researchers, in practice Sanchez and colleagues report that “systematic and empirical recordings of [design-based research] processes are rare and we lack empirical evidences about how these processes are carried out” (2017, p. 2). Thus, our work presented here aims not only at the co-creation of a brokered knowledge (on teaching critical thinking), but also at providing a thorough description of the processes at play. Before describing our design-based research protocol, we further detail the specific context of our study, in particular the specificities of the knowledge to be brokered: teaching critical thinking.

1.2 Improving teaching critical thinking

Teaching critical thinking is a persistent educational priority according to international bodies (UNESCO, 2016; Vincent-Lancrin et al., 2020) and can be found in many curricula, for instance in France where the current study took place (Fuchs-Gallezot & Bächtold, 2023). However many teachers feel unprepared for this mission and may lack a deep understanding of what critical thinking is (Yuan & Liao, 2023).

1.2.1 Existing resources on teaching critical thinking

Resources are “a material entity, actualized in practice with students” (Bruillard, 2020, p. 4, our translation), and could be useful to help teachers teach critical thinking. In another educational research field, open educational resources (OER) can be defined as materials freely available online that anyone can use in relation to teaching, learning and research (Zimmerman et al., 2023).

The existing resources about teaching critical thinking in France, where this study takes place, come mainly from institutional structures such as the Centre de Liaison de l'Enseignement et des Médias d'Information (CLEMI) in relation to information and media literacy (Bosler, 2023) or the Réseau CANOPÉ which provides teacher training and digital resources. Most resources provided by these structures are created by teachers or other education-related professionals, but are not

research-informed nor originating from collaborations between teachers and researchers. For instance, the institutional priority given to the fight against fake news incentivizes these structures to provide teaching resources on that topic. However, the recommendations given in such resources are contradictory to research evidence (e.g. Altay, 2022) which rather suggests a focus on learning how to identify credible information.

Teachers also rely on various resources such as those created by non-profit organizations or even YouTube videos from popular channels dedicated to critical thinking. To the best of our knowledge, while an in-depth analysis of these videos has not been conducted, several videos promote approaches to critical thinking which are inconsistent with recommendations from the scientific literature on teaching critical thinking as they focus on fallacies instead of 'good' argumentation (Pallarès, 2019), cognitive biases instead of metacognition (Monteiro et al., 2020), or a naïve view of science as opposed to the field of Nature of Science (Bächtold et al., 2021; Hasni et al., 2018).

The educational scientific advisory board (CSEN) nested within the French ministry of national education produced recommendations about teaching critical thinking through a dedicated research-based resource (Bronner & Pasquinelli, 2021). Their definition of critical thinking as well as the educational implications drawn are unfortunately limited to a restricted scientific literature, mostly cognitive psychology, and thus restricts the view of the concept of critical thinking itself, defined as "the capacity of assessing the epistemic quality of available information and—as a consequence of this assessment—of calibrating one's confidence in order to act upon such information" (Pasquinelli et al., 2021, p. 169). While this is arguably very important, we believe that the epistemic dimension, that is, focusing on the confidence one can have that a given information is true or false, misses the very important judgment as to the ethical and political consequences of one's actions, given such a calibration. In addition, many false information inadequately spotted are harmless (e.g., someone trusting my false claim that my flat is purple should not suffer from this misbelief), while true information in specific contexts can be harmful (e.g., an advertisement showing that someone won 1 million euros gambling may be true, but hides that on average people lose money gambling).

We therefore argue that the resources for teaching critical thinking in the French context are limited in helping teachers' use such research, and may instead become

problematic as they may hinder teachers' development of better, more complex views of teaching critical thinking.

A research-based resource produced by the non-profit ÉPhiScience (2022) attempted to summarize the research on teaching critical thinking with a broader perspective than Bronner and Pasquinelli's (2021), but was aimed at scientific communication professionals and not directly teachers. This resource had been initially created by a group of 7 researchers from the educational sciences and psychology field, including two of the authors of the current article, as part of a work commissioned by a French science communication training organization. After full group discussions to define the global contents of the resource, each chapter was written by a few researchers of the group. Due to time constraints, the chapters lacked style consistency and were unequally clear, and overall too academic for a teacher audience.

In order to avoid starting from scratch, we have decided to use this resource as a reference to create a new, research-brokered knowledge resource for teachers. A more appropriate way to convey research for teachers could include more engaging research communication elements (Cooper et al., 2017), and a focus on design both in terms of being visually appealing but also well structured information (Zimmerman et al., 2023). Other recommendations include avoiding researchers' jargon and using short, teacher friendly language (Cooper et al., 2017), and to take into account teachers' needs and habits in terms of resource use for teaching. Elements to facilitate teachers' reflection could include clear definitions of research concepts as well as prompting teachers to reflect on the research by using specific questions. Elements to facilitate teachers' change of practices could include concrete teaching examples as well as a way to evaluate students' progress.

1.2.2 Networks dedicated to teaching critical thinking

Such a resource to facilitate teachers' use of research on teaching critical thinking should be made openly available for teachers to reuse and adapt as an open educational resource. But standalone resources, even of high quality, may not be enough to guarantee their use by teachers (Cooper, 2014; Rycroft-Smith, 2022). More time-consuming guidance alongside the resource is most likely needed (Cooper et al., 2017), which can best be done as part of teachers' and researchers' networks (Cooper, 2014). These networks can be understood as "sustained, collaborative interaction in an effort to facilitate learning" (Cooper & Rodway, 2018, p. 12). While resources by themselves may not be sufficient, they are

however key to facilitating teachers' use of research both as a go-to reference and a way to hook teachers to participate in networks (Campbell et al., 2017).

The creation of a network dedicated to teaching critical thinking can be inspired by the field of research-practice partnerships (Sjölund et al., 2023), and be linked to the design-based research aiming at co-creating open educational resources with, and for, teachers. The framework developed by Atal and colleagues (2022) inspired by teacher research (Cochran-Smith & Lytle, 2015) guides educators, during collaborative workshops, to document "1) document educational challenges they face, 2) describe actions to overcome those challenges, 3) collect relevant data from schools prior to, during and possibly after implementation of the action and 4) share structured feedback, or research reports including a contextualized analysis of the effect of the action in relation to the challenge" (Jeune et al., chapter 2, p. 88). This framework could be adapted to build a network in pair with the creation of a research-brokered resource. The educational challenges and actions documented within such a network could continuously nurture a resource on teaching critical thinking. Such content improvement of the resource through the network contributes to the promising features to facilitate other teachers' use of research on teaching critical thinking.

1.3 Aims & research questions

Our aim is to co-create (1) a research-brokered resource and (2) a network of educators dedicated to teaching critical thinking, through a design-based research approach inspired by research-practice partnerships and brokerage. The resource should include features which facilitate teachers' use of research on teaching critical thinking. The network should help teachers benefit from the resource as much as possible, while back-feeding the resource with new knowledge created from teacher-led research.

Our research questions therefore focus on the characteristics of the resource produced throughout this research in line with the work done in the network:

- Which features of a resource on teaching critical thinking were perceived by researchers and teachers participating in the design-based research project to be:
    - appropriate for a target audience of teachers?
    - likely to facilitate the reflection on teaching critical thinking ?

    - likely to facilitate the incorporation of research-informed teaching critical thinking practices ?

- To what extent could each of these features be integrated in the resource created?
- How can a network and a resource, both aiming at facilitating teachers' use of research about teaching critical thinking, be connected throughout a design-based research?

2. Methods

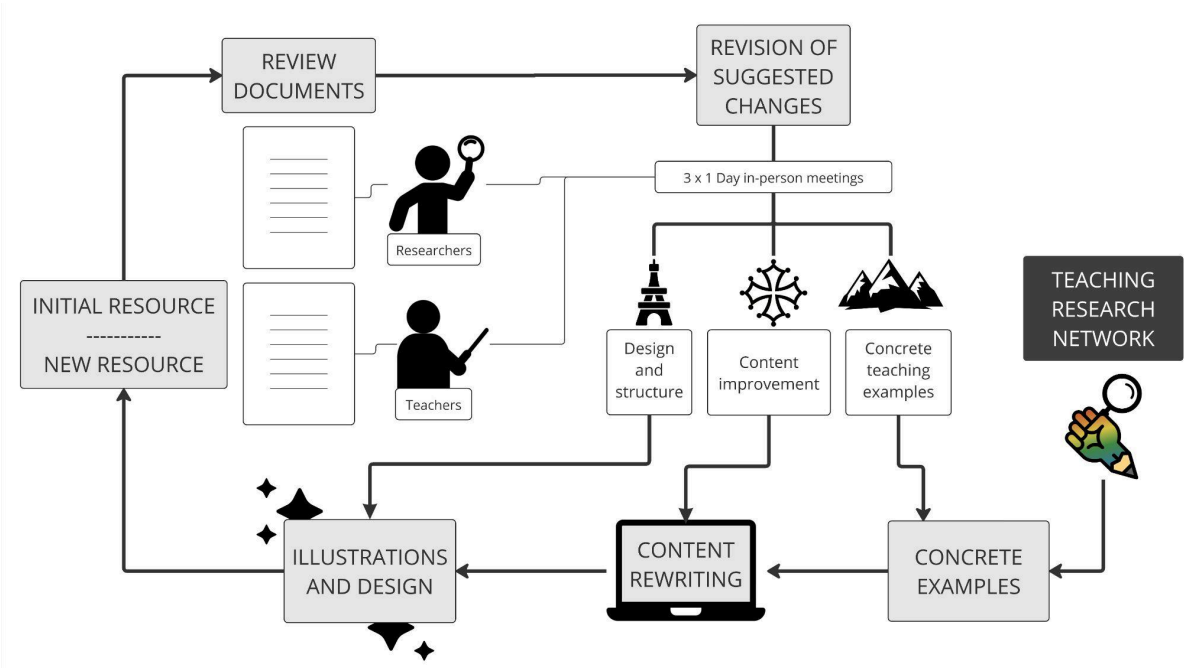
As a starting point of this research, between September and October 2022, two of the authors (NJ and NT) slightly adapted the research-based resource produced by ÉPhiScience (2022) with two goals in mind. First, as the initial resource had been written by various researchers with different writing styles, we wanted to harmonize the different chapters. Second, we wanted to try new ideas, such as a short summary at the beginning of each chapter.

We used this slightly improved version of the resource (from now on referred to as 'initial resource') as a starting point for our design-based research project (Sanchez & Monod-Ansaldi, 2015). We wanted to involve teachers and researchers to collaboratively create a better version of the resource (from now on referred to as 'new resource') in order to facilitate teachers' use of research on teaching critical thinking.

The process we conducted was meant to be iterative, and to include the following steps summarized through Figure 1, each of which would lead to some data collection and data analysis enabling the next step. We first invited teachers and researchers to review the initial resource. We then categorized the review comments according to the kind of changes suggested, and organized in-person meetings to prioritize the different suggestions. The result of this work was used to guide the writing of the new resource. In parallel, we facilitated workshops as part of a network dedicated to teaching critical thinking following Atal and colleagues' (2022) framework for teaching research. The challenges and actions described by teachers working as part of the network were included as concrete examples in the new resource. We collected and analyzed data both to prepare the next step of the iterative process and to answer our research questions concerning the process itself.

Figure 1.

Overview of the design-based research cycle from initial to new resource.



2.1 Review of the initial resource

We created documents with questions aiming to guide reviewers of the initial resource to take notes about possible ways for improvement. We created two different lists of questions: one for teachers, another for researchers. We will from now on refer to these documents as 'review documents'.

Each review document included instructions. For instance, reviewers had no obligation to review the entire initial resource, but may focus on sections close to their field of expertise or interest. It also included information about the participant (name, research focus or students' level), general questions about the initial resource, and chapter-related questions.

Teachers' review document focused on ideas of educational practices related to the research provided in the initial resource, whereas researchers' review document focused on the research-based content. We chose to differentiate review documents in order to benefit from each stakeholders' expertise while being aware of the time-consuming nature of the review and the limited time that educational stakeholders could spend on it.

2.1.1 Participants

For the recruitment phase, we contacted teachers and researchers in our personal and professional networks who already expressed an interest or skills in relation to teaching critical thinking, and through social media. For instance, we invited all researchers who contributed to the creation of the initial resource (ÉPhiScience, 2022). We sent a personal copy of the review document adapted to their profile to each educational stakeholder who expressed interest in participating. We reminded them regularly of their possibility to participate in the review of the initial resource between November, 2022 and February, 2023.

A total of 13 researchers from 7 different fields (philosophy, educational sciences, medicine, information and communication science, didactics, cognitive psychology and linguistics), 15 teachers (1 primary school, 12 middle and high-school, 2 vocational training) and one high-school teacher and researcher (doing a PhD in parallel of her teaching) participated in the review. Table 1 summarizes the information about the participation in the review.

Table 1.

Description of the participation in the review based on the review documents.

	Degree of participation according to filling review documents		
	Substantial	Limited	None
Researchers' review documents	10	3	7
Teachers' review documents	8	7	3

2.1.2 Data organization

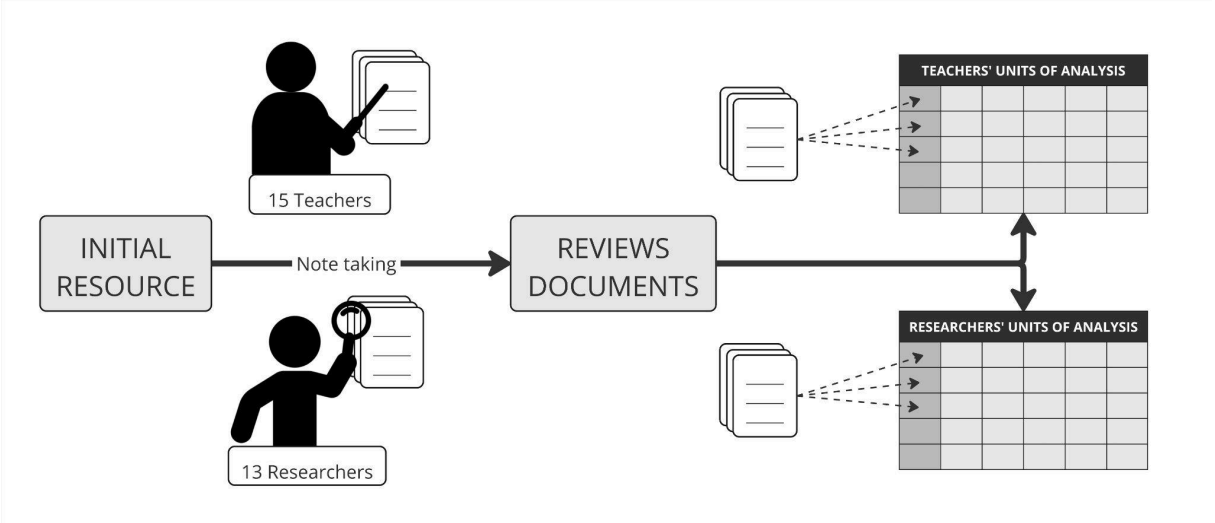
For most participants, the data used for the study was all the notes written by the participants on their review document, but other ways to collect data were used to accommodate some participants, which we eventually incorporated into their review document.

All relevant information, categorized as meaning units, were integrated into two tables, one for teachers' review documents and one for researchers' review

documents. The following figure illustrates the process of the review of the initial resource.

Figure 2.

Review of the initial resource.



2.1.3 Data analysis

We carried out a grounded theory analysis (Cohen et al., 2018) of each review document filled by participants using the following procedure including constant comparison (id.) and three types of coding: open, axial and selective (id.).

The review using the researchers' review document conducted by two authors (NJ and NT) initially allowed us to identify codes for suggested changes, each meaning unit being associated with a single code. A suggested change corresponds to any suggestion for modification, problem raised, nuance to be made, error to be corrected, or other explicit or implicit expression of a change perceived as desirable with a view to improving the initial resource, as well as any associated justification. This preliminary list of codes was revised and improved with the help of the other authors of this article through internal discussions.

The first author then read all review documents, selected meaning units related to suggested changes, and condensed each meaning unit. Each condensed meaning unit was then attributed one code, and then the codes were iteratively improved until they best represented the total meaning units. Finally, the different codes were grouped into several more abstract categories. The details of these steps can be found in appendix 5.

2.2 Revision of suggested changes

Based on the categories of codes from the analysis of the reviews, we identified three different areas of improvement for the new resource : (1) improving the theoretical contents; (2) adding concrete teaching examples; and (3) improving the style and structure of the document. We organized a one-day, in-person meeting (thereafter ‘meeting') for each area of improvement, the goal of which was to reject, or accept and prioritize the changes suggested in the previous step, following what will hereafter be referred to as a ‘decision framework’.

We invited all reviewers to participate (remotely before the meetings if they could not attend in person).

For each meeting, we sent to participants a collaborative on-line document on which we grouped similar meaning units when they suggested changes on similar contents concerning the meeting-specific area of improvement. Participants were then invited to judge each group of suggestions and leave comments to guide the writing of the new resource.

In order to increase the diversity of participants across meetings, each of them was organized in a different city in France (Toulouse, Grenoble and Paris respectively). The meetings were facilitated by the first author of this paper with the help of the co-founder and CEO of the non-profit organization ÉPhiScience.

2.2.1 First meeting – Content improvement

The three researchers who participated in this meeting were from three different fields (educational sciences, information and communication science, and cognitive psychology). The two teachers who participated in this meeting are secondary school science teachers.

During the first meeting, participants followed a decision framework to decide, for each group of suggested changes, whether to accept it as it is, to accept pending a clarification, a reformulation or a different phrasing, to put it aside, or to express their difficulty to judge. Then, for the suggested changes to be accepted, the participants rated the degree of importance (high, medium, or low). Finally, they had the option to add comments and justification for their choices. The figure below illustrates how it was displayed to the participants.

Figure 3.

Example of a decision framework for the content improvement meeting.

Collaborative argumentation - Draft the idea associated with the sentence "Part conclusion: possibility of digging into avenues for teaching critical thinking via argumentation, such as the work on collaborative argumentation (Andriessen & Baker, 2020)." - Develop the section on collaborative argumentation	☐ ☐ ☐ ☐	Accept as such Accept with rephrasing Put aside Hard to judge
Degree of importance 👉 HIGH / MEDIUM / LOW		
👇 Clarification / reformulation / alternative / justification 👇 (depending on the box checked)		

The last goal of the first meeting was to make suggestions about the most important chapters to be included in the new resource.

2.2.2 Second meeting – Concrete teaching examples

The two researchers who participated in this meeting were from cognitive psychology and linguistics. Among the four teachers who participated in this meeting, one was a primary school teacher whereas the other three are secondary school science teachers (two teacher-librarians and a history and geography teacher).

During the second meeting, participants followed a decision framework to prioritize among, and develop, the different ideas of teaching practices suggested. It included participants' rating of the ideas as especially interesting, possibly interesting, or either unclear or too abstract. Participants had to justify why they selected some ideas as 'especially interesting'.

The goal of the second meeting was to have written at least one action per thematic section of the new resource, including elements such as the pedagogical goal of that practice, critical thinking skills and dispositions to be developed through this practice, school level and subject matter related to that practice, quotations from the initial resource used as a justification for the choices made, and finally a detailed teaching sequence including duration, individuals involved to implement the action, materials used, etc.

Figure 4.

Example of a decision-framework for the concrete teaching examples meeting.

Goals, criteria, processes Educate students about the relevant goals, criteria and processes to be mobilized in order to be critical in a particular activity... Give examples related to the passage "Another promising approach would be to develop ways of educating students about the relevant goals, criteria and processes to be mobilized in order to be critical in a particular activity." Explain the goals to be achieved in debates or other situations.	☐ ☐ ☐	Especially interesting Possibly interesting Unclear / too abstract
👇*If you find it particularly interesting, explain why (using the criteria)*👇		
Write here the pedagogical intention / the objectives of the practice / the problem it seeks to solve / the challenge it aims to overcome		
Write here the skills or dispositions related to critical thinking and the curriculum that the action could develop		
Write here the grade level(s) and school discipline(s) for which the action is relevant/curriculum-related		
Write here the passage(s) from the resource that could serve as inspiration for the action / justify its potential for achieving the set objective.		
Write the sequence of events here: Process of preparation Stages (duration, people involved, materials used, etc.) : 1) X		

2) Y

3) Z

2.2.3 Third meeting – Design and structure

The two researchers who participated in this meeting were from cognitive psychology and educational sciences. The two teachers who participated in this meeting are secondary school science and history and geography teachers.

During the third meeting, participants followed a decision framework to validate (Yes or no) and prioritize (high, medium, low) the suggested changes similarly to previous meetings. They were also invited to suggest a new structure (chapters and subchapters) for the new resource. The work on the structure was conducted through a collaborative online tool on which participants could write and move virtual post-its. The goals of the meeting included to organize and hierarchize the information presented (chapters and subchapters) as well as suggest systematic editorial choices for each section (e.g., finishing each section by reflective questions).

2.2.4 Data analysis

The revised suggested changes were systematically analyzed by the first author according to their appropriateness for a teacher audience, and their capacity to facilitate the reflection and the changes in practices regarding teaching critical thinking, but also according to their relevance, consistency, and practicality (Nieveen & Folmer, 2013).

A four-possibility framework has been established in order to filter the meeting participants' judgment about the groups of suggested changes: (1) the group of suggested change was incorporated or rejected according to the decision made during meetings (in the first case the first author briefly described how the suggested change had been incorporated); (2) the group of suggested change was not applicable to the new resource (e.g., suggested rephrasing of a sentence from the initial resource which did not appear in the new resource); (3) the meeting participants' judgment about the group of suggested change was not taken into account and a justification was provided by the first author; (4) the suggested change was considered as important by meeting participants but was too complicated or time-consuming to be taken into account in this new resource, and were left as suggested changes for a future version of the resource.

Figure 5.

Example with a group of suggested changes taken into account.

CT = Knowledge + Skills + Dispositions - Further develop the description of critical thinking as made up of 3 main components: dispositions, skills and knowledge. - Draw a parallel with another vocabulary in which critical thinking is a skill made up of Knowledge + Know-how-to-be + Know-how + Methodological knowledge. - When presenting the dispositions/skills/knowledge breakdown, make the link with more familiar notions (*savoir, savoir-faire, savoir-être*) and distinguish from "intuitive" / everyday notions (e.g., "attitudes" - be careful what you mean by that).	☑ ☐ ☐ ☐	Accept as such Accept with rephrasing Put aside Hard to judge
Degree of importance 👉 **LOW**		
👇 Clarification / reformulation / alternative / justification (depending on the box checked) 👇		
…		
Description of the change made: The characterization of critical thinking begins with this triptych, which is defined and exemplified. A parallel is drawn with another vocabulary, but the decision to use these terms is made explicit.		

2.3 Teachers network documenting challenges and actions on teaching critical thinking

2.3.1 Participants

In parallel to the revision of the resource, we created a teachers network following teaching research methods (Atal et al., 2022, Cochran-Smith & Lytle, 2015) to document challenges related to teaching critical thinking, and actions to address those challenges. The documents created by this network were intended to nurture the new resource. Participants to this network were recruited through the author's personal and professional network and social media. A total of 13 teachers (2 primary school and 11 secondary school teachers teaching various subject matters), one teacher and researcher (high school teacher doing a PhD) and 4 other educational stakeholders but no full-time researchers participated in the network.

Among those, 6 teachers plus the teacher doing a PhD participated in the review or the in-person meetings.

2.3.2 Network description

The available participants of the network met regularly online through 2-hour long open workshops (thereafter 'workshops') facilitated mainly by one of the authors (NJ). This network was part of a larger collective of educational stakeholders who make public their challenges and actions on a dedicated open collaborative platform (https://plateforme.profschercheurs.org/, Atal et al., 2022). During the workshops, the facilitators aim was to engage teachers in a process use of research through the teacher-led conduct of research methods. This includes problematizing their challenges before jumping on to actions (which is usually teachers' first interest), collecting and analyzing data to evaluate the effects of their daily teaching in comparison to the actions they may implement, and peer-reviewing others' writings. In addition, throughout the description of their challenges and actions, they are invited to take inspiration from relevant academic research for both conceptual use and instrumental use of research.

The following table describes the expected constituents of challenges and action documents used by the network participants. Each action is by design related to a unique challenge.

Table 2.

Descriptive elements for teacher research challenges and actions (Atal et al., 2022).

Challenges	Actions
Title (starting with "How… ?")	**Title**
Scope of the challenge (Which specific educational sector, level, system, or context is concerned by this challenge?)	**Scope of the action** (In which specific educational sector, level, system, or context can this action be implemented?
____ ____	**Target of the action** (whether the focus is on one student, a group, whole-class or school level, but also teachers, parents, and so forth)

Actors involved in addressing the challenge (which stakeholders could be involved in preparing and/or implementing solutions to address this challenge?)	**Actors involved** in preparing and implementing the action (which stakeholders could be involved in preparing and/or implementing this action?)
General description of the challenge including a description of 1) the problematic situation, or starting point ; 2) ideas about the underlying causes and 3) the desired final situation, or objectives	**General description** of the action including a description of the different steps to implement, the necessary (human, material and other) resources, the frequency and length of its implementation.
____ ____	**Argumentation** regarding why this action is relevant and adapted to overcome the challenge it is related to.
Approximate time needed to overcome the challenge	**Approximate time needed** to see effects due to this action
Progress indicators which are simple data related to problems and objectives previously described, which can serve as a diagnostic tool as well as the evaluation of the effect of subsequently implemented actions.	**Protocol elements** which are simple data about the implementation which may vary from one context to the other and that should be communicated in order to accurately understand how the action was implemented.
[Optional] **Concrete examples** of how the challenge takes place in the author's specific context	[Optional] **Concrete examples** of how the action has been, or could be, implemented in different contexts or with variations
[Optional] **References** of all the articles, books, and other sources cited in the previous sections.	[Optional] **References** of all the articles, books, and other sources cited in the previous sections.

In order to ensure an alignment between the work from the network and the revised resource, all concrete teaching examples identified during the second meeting (c.f. Section 2.2.2) were transformed into partially described challenges

and actions for the network. Nonetheless, the network could create challenges or actions without any link with the revision of the resource.

Towards the end of this research, network participants could connect their documents describing challenges and actions to the contents of the new resource. The participants could also pursue their work after the end of this research (e.g. finalizing the description of a challenge, suggesting a new action). Instead of including in the new resource the fixed documents as they looked like by the end of this research, we included hyperlinks to the living documents in the open collaborative platform used by the network. This allows the network to continuously improve and nurture the resource. The titles of the challenges and actions produced by the network between its creation in February, 2022 and the production of the new resource in June, 2024 can be found in the results section.

2.3.3 Data analysis

The challenges and action documents included in the new resource were analyzed according to their degree of completion (Table 2) in relation to the corresponding potential of each descriptive element to affect teachers' process, instrumental and conceptual use of research. Even though arguably all descriptive elements of challenges and actions could facilitate each of these three kinds of use, we simplified the analysis by categorizing as facilitating process use the complete description of progress indicators and protocol elements, as facilitating instrumental use the complete description of an action and of concrete examples for either challenge or action, and as facilitating conceptual use the complete description of a challenge description and of action's argumentation.

2.4 Creating the new resource

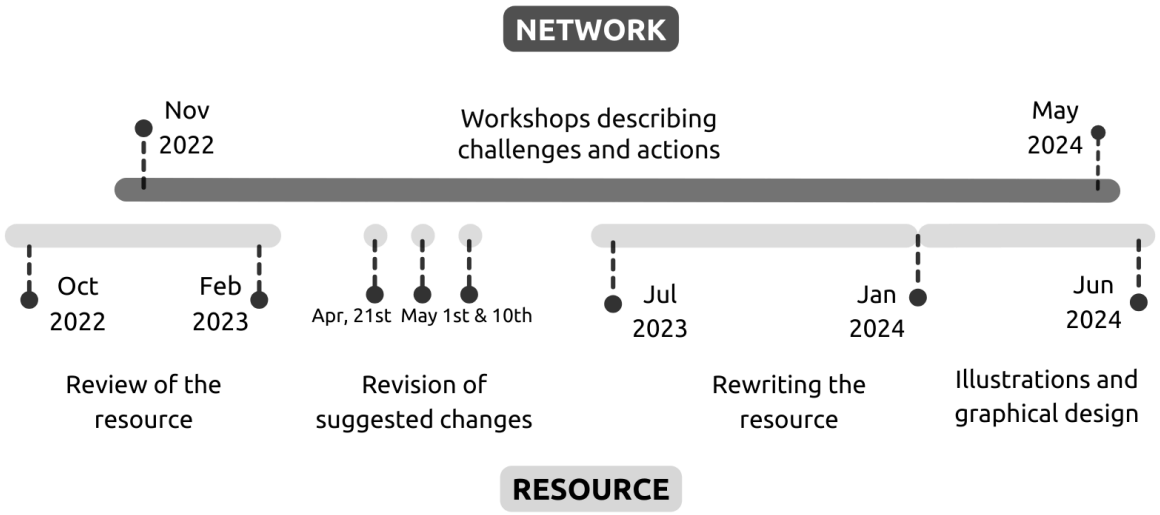
Additional exchanges with researchers between May and July following the results of the meetings helped the authors write the contents of the new resource. The first author then wrote a first draft of the new version of the resource until December, 2023, taking into account the work on the structure done during the third meeting, and all comments prioritized during the first meeting. The participants of the previous steps were then invited to provide comments up until mid-January, 2024. Between January and February, the first author finished writing the new resource, taking into account as much as possible the last comments left.

The addition of concrete examples of teaching critical thinking practices, which was considered as important, was done by linking the challenges and actions

documents produced by the network into dedicated sections of the new resource (using hyperlinks to the living documents in the open collaborative platform used by the network). In addition to changes being made to the content, we have also worked on the visual elements with a graphical designer with expertise in scientific communication. The first author collaborated closely with him to ensure that the visual elements conveyed an accurate vision of the contents and that the visual elements incorporated the recommendations about the design of the new resource. The graphical designer was asked to produce illustrations and diagrams in order to make it easier to access the relevant information as well as to facilitate its memorization. That work included visual syntheses of each chapter of the new resource or specific graphical elements for inserts such as in-text definitions or concrete examples.

Figure 6.

Timeline of the process to improve the initial resource.



3. Results

3.1 Review of the initial resource

The descriptive analysis of the review documents can be found in Table 3 below. From 27 review documents, we identified 1203 meaning units from the content written by reviewers. Among these, 1038 meaning units were categorized into three categories: suggesting a change for the resource (N = 805), expressing the perceived usefulness of the resource (while not making any specific suggestion, N = 139), and suggesting corrections about grammar or spelling improvements which

could be considered as objective and consensual (= 94). The remaining 166 meaning units were excluded because they did not refer to any of these categories but rather expressed comments which were not relevant for the analysis. The meaning units falling into the category “Suggested changes” were further categorized into sub-categories as shown in the table below (Table 4).

Table 3.

Descriptive statistics of teachers’ and researchers’ review documents’ content.

Meaning units	**Teachers (N = 15)**	**Researchers (N = 13)**	**All (N = 27)**	**Percentage of the total**
Suggested changes	**346** (43%)	**459** (57%)	**805**	78%
Perceived usefulness	74 (53%)	65 (47%)	139	13%
Corrections	12 (13%)	82 (87%)	94	9%
TOTAL	**432** (42%)	**606** (58%)	**1038**	**100**%
Excluded	151 (91%)	15 (9%)	166	/

Table 4.

Categories of codes from teachers’ and researchers’ review documents’ contents.

Categories	*Codes included* (examples of meaning units)	Number of meaning units
Consolidate the existing content	*Develop the reasoning* ("Add that it is difficult overall to rank and prioritize the dispositions essential to EC"); *Change the reasoning* ("Suggest that critical thinking should be seen as the implementation of other types of heuristics, which in some cases may turn out to be erroneous."); *Introduce an important author* ("Add a short video presenting, for example, Paolo Freire and the kind of people or figures who are key when you think about the history of critical thinking and teaching critical thinking"); *Justify*	173

	("Justify the part ‘We do not necessarily share this point of view’ “); *Give examples* ("Use more examples from schools to make technical concepts easier to understand")	
Refine the message	*Clarify the reasoning* (Clarify what is meant by ‘basic elements'?"); *Simplify* ("Make the section on the criticism of a form of ‘positivism’ more accessible to lay teachers"); *Shorten* ("Remove redundant parts between text and table"); *Clarify the recommendations* ("Make the recommendations more actionable and clearer, particularly the final recommendations")	141
Improve the layout and visuals	*Diagramming information* ("I would regularly add diagrams"); Improve the information structure ("Make the synthesis less linear and present the ‘in a nutshell’ boxes earlier"); *Articulate the chapters together* ("Set the context and link this section with the previous sections"); *Give access to the references* ("Provide easy access to the sources on which the synthesis is based (clickable links in the PDF, file on the website, etc.)"); *Reorganize the information* ("Give greater prominence to the section on evaluation, for example before the list of skills, even if it means repeating it in the summary at the end of the chapter."); *Adapt to teachers* ("Adopt a writing style and a way of presenting ideas that is less academic, jargony or technical")	148
Total suggested changes to improve the appropriateness for the target audience		462
Add new elements	*Add references* ("Maybe I would include a reference to an easy-to-access resource to help people understand in what way these ideas are flawed"); *add content* ("Add elements on how media work")	63

Define	*Define* ("Improve the definition by saying what an argument is")	40
Total suggested changes to improve conceptual use facilitation		103
Share ideas for classroom activities	*Plan action [in X subject matter]* ("Session on the experimental method (devising a protocol) in Life and Earth Sciences"); *Plan action generally* ("Metacognitive exercises in cogni'classes"); *Suggest action plan* ("Explain how to work on developing metacognitive skills in practice"); *Concrete example* ("classroom debate")	230
Change teaching	*Train teachers* ("I present the concept of epistemic beliefs to my Life and Earth Sciences colleagues during a training course"); *Develop new collaborations* ("Increase collaboration with colleagues from all disciplines"); *Change practices* ("Work more explicitly on planning a task. For example, what tasks does a presentation require? How can they be divided up according to the actual date requested by the teacher?"); *Change posture* ("I always refer to these things about metacognition at regular intervals and ask myself what I've done in this respect")	10
Total suggested changes to improve instrumental use facilitation		240

The analysis of this content suggests that, for a brokered resource to be perceived as appropriate for a target audience of teachers (RQ1), teachers and researchers consider it is important to ‘Consolidate the existing content’, ‘Refine the message’ and ‘Improve the layout and visuals’. Similarly, for a brokered resource to be perceived as facilitating conceptual use (RQ1), they consider it is important to ‘Add new elements’ and ‘Define’. Finally, for a brokered resource to be perceived as facilitating instrumental use (RQ1), they consider it is important to ‘Share ideas for classroom activities’ and ‘Change teaching’ are mainly related to facilitating the incorporation of research-informed teaching practices. The higher number of suggested changes is related to the appropriateness for a teacher audience (N =

462), followed by suggested changes to improve instrumental use facilitation (N = 240), and then suggested changes to improve conceptual use facilitation (N = 103).

3.2 Revision of suggested changes and integration in the new resource

The categories of suggested changes were spread over the three meetings as described in the table below.

Table 5.

Categories of meaning units treated in each meeting.

	Meeting 1 Content improvement	Meeting 2 Concrete teaching examples	Meeting 3 Design and structure
List of the sub-categories	- Add new elements - Consolidate the existing content - Refine the message - Define	- Share ideas for classroom activities - Change teaching	- Improve the layout and visuals
Number of suggested changes associated	417	240	148

3.2.1 Meeting 1 - Content improvement

The participants of this meeting were in charge of revising 417 suggested changes organized into 206 groups to be sorted. There was a wide variation in the judgment of each group of suggested changes. Out of the 206 groups, 96 were rated as 'Accept as such', 12 as 'Accept with rephrasing', 6 as 'Put aside' and 10 as 'Hard to judge'. All other judgments included a combination of 2 different judgments (n = 76) or 3 different (n = 6), most of which included a mention of 'Hard to judge' (n = 69), which indicates that having multiple participants' opinions was indeed important. The majority of the groups of suggested changes were not assigned any priority (n = 122), and the remaining prioritized groups, were more or less balanced between the rating high (n = 30), medium (n = 30) and low (n = 21), with an addition

of 3 groups rated both as medium and low. A justification or explanation of the ratings was given for 60 groups, leaving 146 empty. The table with the condensed results of the first meeting, displaying the judgment, the priority, the presence or absence of a justification and whether it was integrated in the new resource, is available in appendix 6.

Out of the 206 groups, we have fully integrated in the new resource 92 groups, plus 17 which have been partially included for a total of 53% of all groups (n = 109). Among the integrated groups of suggested changes, 23 have been rated as of high importance (out of 30, so 77% of the high rated groups), 20 medium (out of 30, or 67%), 2 medium and low (out of 3), 7 have been rated as of low importance (out of 21, or 33%), and 57 haven't been rated (out of 122, or 47%). This seems to indicate that, on average, the comments judged by participants as the most important were more taken into account than the lower rated ones. Among the 89 groups that were rejected, 53 rejections were due to a change in the content of the new resource which made the suggested change irrelevant, for instance when a suggested change was rephrasing a sentence which did not exist in the new resource. In total, only 16 groups have seen the recommendations made at least partially left for a future version, which means most of the suggestions could be taken into account whenever they were judged relevant.

3.2.2 Meeting 2 - Concrete teaching examples

Out of the 240 suggested concrete examples, participants could only describe in detail 7 examples for which they filled the decision-framework for the concrete teaching examples (see Figure 4 in the section 2.2.2). These 7 examples were then integrated into the teachers network documenting challenges and actions on teaching critical thinking. As they didn't fit the challenges and actions templates, they were left in the description as a whole so that participants in the network could take inspiration from them. However, only 3 out of the 7 detailed examples were part of challenges integrated in the new resource.

Participants to this second meeting also judged the relevance of many other suggested concrete examples, but they could not detail all of them for two main reasons. First, because the initial suggestions were incomplete or unclear with regards to the expected detailed concrete teaching examples. Second, because the task of describing them is both a complex and very long process.

As our second research question referred to the incorporation of research-informed teaching critical thinking practices in the new resource, our results indicate a very limited incorporation of the work done as part of the second meeting or the suggested concrete examples. The integration of the detailed examples into the network was more promising in relation to our third research question: 'how can a network and a resource, both aiming at facilitating teachers' use of research about teaching critical thinking, be connected throughout a design-based research?'.

3.2.3 Meeting 3 - Design and structure

The work done during the third meeting led to the following two outcomes. First, recommendations were made regarding the structure of each of the chapters, including the kind of visual elements they would require. Second, the work done on a virtual board allowed the group to create and move virtual post-its representing the possible new chapter titles. It allowed to see a pattern emerge of including as part of each of the chapters a subsection dedicated to what should not be taught in relation to critical thinking. As such, it contributed to the idea that this resource could not only give relevant research-based suggestions, but also embed them in a narrative of replacement of common misconceived or problematic ways to teach critical thinking. This contributes to answering our second research question about the integration of elements appropriate for a target audience of teachers in the new resource. Based on the work done during the third meeting, we could integrate a structure in the new resource which took into account teachers' preexisting teaching critical thinking practices, and was thus better adapted to them.

3.3 Challenges and actions identified by the network of teachers

Between the creation of the network in February 2022 and June 2024, we facilitated a total of 38 two-hour online workshops with 2 to 5 participants each. The person who participated in the highest number of workshops participated in 13 workshops.

A total of 15 challenges and 9 actions dedicated to teaching critical thinking have been created by the network. The table below summarizes the various contributions of each challenge and related action to the process use of research (fully completed challenges' progress indicators and actions' protocol elements increased the count by 1 each), the instrumental use of research (presence of a fully

completed action description and concrete examples for either challenge or action) and the conceptual use of research (presence of a fully completed challenge description and an action's argumentation) according to the degree of completion of each relevant section.

Table 6.

Potential of the network's challenges and actions to facilitate teachers' use of research.

	Number of elements included in the corresponding document facilitating different types of use of research			Number of research cited
Challenges' (C) and related actions' (A) titles	Process use	Instrumental use	Conceptual use	
C1 - How can we facilitate the transfer of critical thinking skills?	1	1	1	0
C2 - How can teachers be helped to adopt attitudes conducive to the development of students' critical thinking skills? A2.1 - Training teachers to analyze information with arguments from different perspectives A2.2 - Training teachers to adopt attitudes that take into account the uncertain nature of knowledge, relating to the epistemological dimension.	1	2	1	6
C3 - How can the epistemic and social/ethical/axiological	0	0	0	0

dimensions be articulated when teaching critical thinking?				
C4 - How can we develop students' oral argumentative skills on socio-scientific issues? A4.1 - Explain the different components of an argument to students **A4.2 - Use V-shaped argument diagrams with critical questions**	2	2	2	4
C5 - How can I adopt a non-genre stance as a teacher?	1	1	1	0
C6 - How can we help secondary school students to develop their critical judgement in the context of teaching philosophy? A6.1 - Sequence around the theme of gender with the game Expedition Wisdom	2	1	1	2
C7 - How can we get secondary school pupils to develop a critical mind around the question of gender?	1	0	1	0
C8 - How can students evaluate a source across different school disciplines? **A8.1 - Work with the pupils to draw up a list of quality criteria for sources, based on**	2	4	1	0

a predefined corpus of documents. **A8.2 - Ask the pupils questions about the evaluation of sources.**				
C9 - How can we develop students' oral argumentation dispositions in relation to socio-scientific issues?	0	0	0	0
C10 - How can students' perceptions of sciences be improved? A10.1 - Interdisciplinary work on different representations of the Earth and its movements **A10.2 - Get students to identify the limits of reductionism**	1	2	2	4
C11 - How can we help students develop intellectual humility?	1	0	1	2
C12 - How can the foundations of critical approaches be introduced to students in a school setting?	0	0	1	0
C13 - How can students be helped to analyze the processes involved in orienting information?	0	0	1	0
C14 - How can we help students to take a critical approach to media images?	0	1	1	2

C15 - How can we help to link feelings and reflection in a research questioning situation?	0	2	1	3
TOTAL	12	16	15	23

Among these challenges and actions, the ones in bold represent those which have been included in the new resource, for a total of 6 instances to facilitate process, 9 instrumental, and 9 conceptual use of research, and 12 references to academic research. As our second research question focused on the integration into the new resource of elements likely to facilitate conceptual and instrumental use of research, this result indicates the significant contribution of the network.

3.4 The new resource on teaching critical thinking

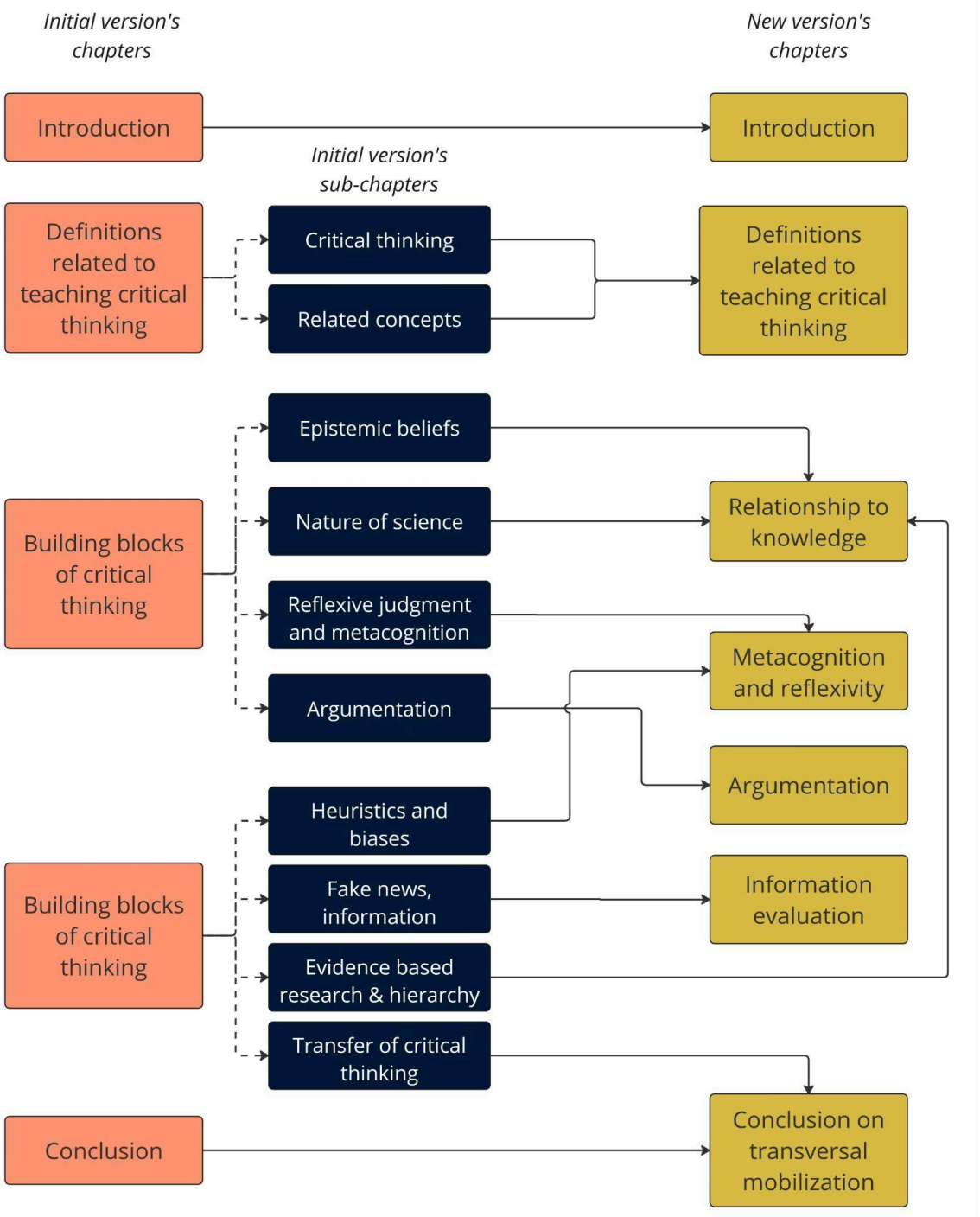
Our focus in this section is the contribution of the structure and design of the new resource regarding our research questions. We have covered the changes in the content in relation to the revision of the suggested changes meetings and the detailed benefits of the conception of critical thinking in the new resource are described in another article (Jeune et al., chapter 5).

3.4.1 New chapter structure of the resource

The figure 7 represents the evolution of the chapter structure of the resource, from the initial resource to the new resource. The dotted links represent the filiation between chapters and sub-chapters of the initial version of the resource, whereas the arrows illustrate where the content of the initial resource has been integrated among the different chapters of the new resource. Our second research question included the integration of a more appropriate structure for a target audience of teachers. Interestingly, the new resource favored chapter titles that avoided as much as possible the research jargon of the initial resources, so as to make it more appropriate for a target audience of teachers.

Figure 7.

Chapter structure evolution from initial to new resource.

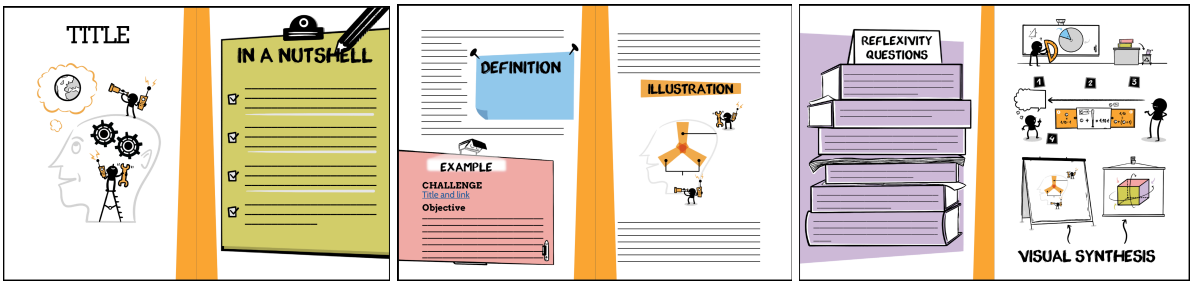


3.4.2 Design of each chapter

The way each section was organized was different in the new resource, as we have a recurrent, easier-to-read pattern as is illustrated in the figure below.

Figure 8.

Overview of a chapter of the new resource.



There is a specific illustration for each title. Then, the chapter starts with a “in a nutshell” section, which aims to provide an easy-to-read summary of the contents of the chapter. Afterwards, throughout the contents of the resource, the definition of key terms were provided on pinned notes illustrations. Whenever relevant, a challenge (and possibly an action as well) was added on a digital board illustration, with the link to the original detailed content, linking with the network and possibly encouraging others to join. At least once per chapter, an original illustration contributes to clarifying the content by translating it visually. Then, at the end of each chapter of the new resource, there are some reflexive questions for teachers, prompting them to reflect on what they may have learned through reading the resource (conceptual use of research), and what the next step might be (possibly instrumental use of research). Finally, there is a visual synthesis of the contents of the whole chapter. By saving time, clarifying the concepts used, and providing multiple ways to present the information, we have tentative evidence that the new resource is appropriate for a target audience of teachers (RQ2).

In addition to the visuals, we have also changed the way to introduce the contents of each section. As we explained in relation to the results of the third meeting, we have written each chapter so that a common misconceived or problematic approach to teaching critical thinking is exposed and a more promising, research-based way to teach it is suggested for replacement.

For instance, in the chapter dedicated to the relationships to knowledge, we begin by introducing the problems associated with the use of the hierarchy of evidence and suggest instead to focus on teaching elements related to epistemic beliefs or the Nature of Science. In the chapter dedicated to metacognition and reflexivity, we begin by introducing the problems associated with teaching cognitive biases and suggest instead to focus on metacognitive strategies and related dispositions.

In the chapter dedicated to argumentation, we begin by introducing the problems associated with teaching fallacies and suggest instead to focus on what makes good argumentation, with suggestions of argumentation practices supported by research. In the chapter dedicated to information evaluation, we begin by introducing the problems associated with fighting Fake news and suggest instead to focus on skills and dispositions related to information search and the evaluation of its credibility.

4. Discussion

Our design-based research project aimed at co-creating a resource about teaching critical thinking which could serve as research-brokered knowledge (Rycroft-Smith, 2022), that is, new knowledge adapted from research and practice, adapted for an audience of teachers (Jeune et al., 2024). In addition, inspired by research-practice partnerships, we aimed at linking the resource to a network of teachers doing research on the challenges related to teaching critical thinking (Atal et al., 2022).

We have coordinated the participation of 15 teachers and 13 researchers from various fields for the review of the initial resource, which led to a total of 805 suggested changes. Then, we organized three in-person meetings to prioritize the changes to be made, and a total of 13 different participants (5 teachers, 7 researchers and one having both roles) who participated in one or two of these meetings. In parallel, we facilitated 38 workshops in our network of teachers focusing on teaching critical thinking which ended up creating 15 challenges and 9 related actions. We will discuss the results of our research project in relation to each of the three research questions, while taking into account some limitations of our project, and then suggest recommendations for future research.

4.1 Analysis of the features of a resource on teaching critical thinking

Building upon previous research which identified specific factors judged by educational stakeholders as influencing teachers' use of research (Dagenais et al., 2012; Jeune et al., 2024), we first asked which features of a resource dedicated to teaching critical thinking could be (1) appropriate for a target audience of teachers, (2) likely to facilitate the reflection on teaching critical thinking, and (3) likely to facilitate the incorporation of research-informed teaching critical thinking practices.

The content analysis of the 805 suggested changes led us to the categorization of 462 suggested changes related to (1) improving the appropriateness for the target

audience as part of three categories: ‘Consolidate the existing content’, ‘Refine the message’ and ‘Improve the layout and visuals’. We categorized 103 suggested changes related to (2) improving conceptual use facilitation as part of two categories: ‘Add new elements’ and ‘Define’. Finally, we categorized 240 suggested changes related to (3) improving instrumental use facilitation as part of two categories: ‘Share ideas for classroom activities’ and ‘Change teaching’. This contributes to answering our first research question about the perceptions of teachers and researchers, showing that all three dimensions inspired by previous research about factors facilitating teachers’ use of research (e.g., Dagenais et al., 2012; Jeune et al., 2024) were to different extents perceived as lacking in the initial resource.

4.2 Integration of features to facilitate teachers’ use of research in the new resource

The analysis of the integration of the suggested changes related to the contents show that suggestions have largely been taken into account, especially considering the higher priority suggestions from the first meeting. This indicates that the new resource could be more appropriate for a target audience of teachers and more likely to facilitate conceptual and instrumental use of research by teachers, though this should be assessed in future empirical research. While the low integration of concrete examples described during the second meeting should nuance the possible facilitation of instrumental use of research with the new resource, there are however a large number of teaching critical thinking challenges and actions from the network which were included in the new resource. From those 7 challenges and 4 actions, our results indicate that they yield a strong potential to facilitate conceptual and instrumental use of research altogether.

In addition, the structure and design of the new resource appears more appropriate for a target audience of teachers as the short summary and the visual synthesis both contribute to saving time to busy teachers, and the definitions throughout the resource help familiarize teachers with important vocabulary while otherwise avoiding unnecessary jargon. The conceptual use of research is also facilitated by the explanation of a misconceived or problematic approach to teaching critical thinking in the beginning of each chapter, followed by a research-based approach to teaching critical thinking. The end-of-chapter reflexive questions further contribute to facilitating the conceptual use by teachers of the new resource.

4.3 Connections between our network and the new resource

The integration in the new resource of challenges and actions described as part of the teachers network shows how the network contributes to improving the resource. In addition to the network contributing to the resource, we have found promising ways in which the resource can also contribute to the network. After the network facilitator finished rewriting the contents of the new resource in January, 2024, the work done by the network benefited from research-based recommendations that can be found in the resource. For instance, the action “Use V-shaped argument diagrams with critical questions” related to the challenge “How can we develop students’ oral argumentative skills on socio-scientific issues?” is directly inspired by the work on critical integrative argumentation by Nussbaum (2021) which can be found in the new resource. In addition, the progress indicators of the challenge were also widely inspired by Pallarès (2019) whose work also infused the new resource.

The two-way positive interaction of both the resource and the network is consistent with Campbell and colleagues stating that “advanced knowledge mobilisation strategies need more than products alone, but products are nevertheless important for effective knowledge mobilisation strategies.” (2017, p. 220). The findings from Cooper (2014) who reviewed a large number of organizations doing knowledge brokering in Canada indicated a dominant focus on resource creation, with a lack of people-oriented work such as fostering networks. Our work therefore goes beyond the usual resource-creation, and the effect on teachers’ use of research due to its connection with a network should be explored in future research. One ongoing research project of the authors of this paper is the integration of both resource and network as part of a teacher training program, and the evaluation of its effect on the evolution of teachers’ teaching critical thinking conceptions, practices, and their students’ critical thinking. This training program can then contribute to future iterations of the improvement of the resource, while adding new challenges and actions, or improving the ones already existing, to those initially created by the network (with possible continuous improvement on an open collaborative platform). This research will also allow us to assess the extent to which the new resource and involvement in the network actually contributes to facilitating teachers’ process, instrumental and conceptual use of research, for which the current study cannot provide evidence.

4.4 Limitations of the current study

The review of the initial resource used two different review documents, one for researchers and another for teachers. This design did not allow us to compare the respective contributions of both groups. This was chosen in order to prioritize the expertise of each group, and as such to avoid wasting teachers' or researchers' time, but remains a limitation of our design in terms of research outcomes.

One major limitation of our process is that the several suggestions of improvement of the resource became irrelevant as the contents of the resource evolved. For instance, among the 89 groups of suggested changes on the contents that were rejected, 53 were due to the fact that the contents on which the comment had been done was already removed. This is a limitation as it implies a loss of efforts from participants who made and analyzed those suggestions. One reason which may explain such an increase of irrelevant suggestions is that the whole structure of the resource evolved. A way to limit the loss of time for reviewers could be to separate more clearly the different steps, for instance starting with reviewing the structure of the resource, and once the resource has been restructured, then ask for suggestions to change the contents, and finally, as the contents are rewritten, ask for suggestions regarding the concrete examples to best illustrate the new contents.

The limited number of suggested concrete examples developed during the second meeting shows the need to think differently about the development of concrete examples to include in the resource. One way to think about improvements regarding the work done on concrete examples is to focus on long-term work done as part of the teachers network, instead of trying to organize short-term activities such as the one-day meeting. Given the teachers' frequently acknowledged lack of time (Anwaruddin, 2016; Cain; 2016; Dagenais et al., 2012; Gentaz & Richard, 2022; Goffin et al., 2022; Hemsley-Brown & Sharp, 2003; Jones et al., 2022; Penuel et al., 2020; Pereira & Fang, 2022; Sjölund et al., 2022), it may not be realistic to leave teachers to work on their own, hence the importance of the network to sustain such collaborative work.

As the participants in the network almost included no researcher beyond the facilitator and coordinator of the network (NJ), future work should focus on the inclusion of more researchers to join and contribute to this network. In this regard, there is a need to better understand the motivations of teachers and researchers so that they can both participate in a mutually beneficial way, which we studied and

reported in another research conducted in relation to this project (Jeune et al., chapter 4).

Another limitation of this research-based design project is that teachers and researchers who participated may not be representative of all teachers, especially considering the absence of participants from some minorities. The underlying goals and priorities of the new resource may therefore not represent the goals and priorities of such minorities, and a crucial equity improvement in a future iteration would be to avoid reinforcing power imbalances. The inclusion of more diverse participants may require resource-intensive incentives, which are highly dependent on the research and educational institutions, more than the researchers in charge of this project. However, we believe that future funding for continuing this research project should be allocated in priority to such an endeavor.

Finally, as this resource creation originates from a French context, with mostly secondary school teachers who participated, teachers from other countries than France with different educational systems or at the primary school level may also lead to focus differently on teaching critical thinking. While this resource remains at a general level, and as such may still be useful for various contexts, we believe that future iterations of the work on this resource should aim at creating curriculum specific recommendations, linking general research advice with curriculum-specific teaching.

4.5 Perspectives

Our research contributed to the landscape of teaching critical thinking by providing a research-brokered (Rycroft-Smith, 2022) resource in French to English. This open educational resource (Zimmerman et al., 2023) can be used as a reference for teacher training, and we encourage other teachers to reuse and remix the resource as they see fit. We encourage future collaborations between teachers and researchers to explore the effects of the use of this resource on teachers and their students, and to keep improving the resource according to local needs. The online collaborative platform used by the teachers network to document the challenges and actions linked to the resource is currently in French, but the framework used by the network for their teaching research can easily be adapted and translated.

Chapter 4: Teachers' and researchers' motivations to engage in collaborative research: two (similar) communities?

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Abstract

The gap between teachers and researchers is often described using the 'two-communities' framework, which posits teachers and researchers in distinct communities with divergent work cultures and expectations. Collaborative research involving teachers has been suggested as a way to bridge this gap. However, little is known about the motivations of both teachers and researchers to engage in such collaborative projects and how these motivations can be enhanced. In the context of a design-based research project, we conducted an exploratory study on the motivations of teachers and researchers to engage in collaborative research. Our survey included a section dedicated to understanding respondents' motivations for engaging in collaborative research in general, as well as sections focused on three specific stages of the design-based research: reviewing and revising a research-informed resource in order to make it research-brokered, participating in online workshops within a teacher-research framework, and attending one-day in-person meetings to prioritize the suggested changes to the resource. We surveyed 30 researchers and teachers having shown interest (but not all participating) in our design-based research. Our results indicate that extrinsic motivations, such as rewards or professional obligations, were not highly motivating for most respondents. Surprisingly, the time required to participate in collaborative research was also a low source of motivation. We found few differences between teachers' and researchers' perceptions of motivational statements. Additionally, in-person meetings participation was higher when respondents did not judge their autonomy in collaborative research as highly motivating but did judge the usefulness of the result or process as highly motivating. Although our small sample size warrants cautious interpretation, our findings challenge the 'two-communities' framework by showing that both groups have similar motivations. We recommend future collaborative research to describe each step of their projects, as the specific nature of the activities may influence what motivates teachers and researchers to engage.

Educational research produces knowledge about teaching and learning which could be useful for teachers, but a wide range of scientific articles documented what is sometimes called a 'research-practice gap' (Crain-Dorough & Elder, 2021; Joyce & Cartwright, 2020; Knight, 2024; Neal et al., 2019). This gap, on one side of which stand researchers, and on the other teachers, has been analyzed through the lenses of a 'two-communities' framework (Caplan, 1979; Crain-Dorough & Elder, 2021; Farley-Ripple et al., 2018; Newman et al., 2016). This framework suggests that teachers' underuse of research may be explained because of their different languages, values and systems (Newman et al., 2016) as well as their different definitions and expectations of research (Mills et al., 2020). In order to bridge the gap between research and practice, collaboration between both communities for the production and use of research appears as key (e.g., Farley-Ripple et al., 2018; Jeune et al., chapter 2). While much is known about teachers' motivations to engage in collaborative research (Landicho, 2020; Thi My, 2018; Ulla et al., 2017; Yuan et al., 2016), little is known about researchers' motivations and the potential differences between both communities. This exploratory analysis aims at comparing teachers and researchers' motivations to collaborate in a design-based research project run by a member of the research team (NJ).

1.1 The two communities framework

Initially developed by Caplan (1979), the two communities theory referred to a gap between researchers and policymakers. Overall, the idea of two communities steps from the distinction between research and practice (Crain-Dorough & Elder, 2021; Sjölund et al., 2023; Taylor et al., 2023) or between knowledge producers and users (Caplan, 1979; Dwan et al., 2015; Malin & Paralkar, 2018), and therefore extends beyond researchers and policymakers. The 'two communities' framework may be problematic as such because it does not always refer to the same communities: it may contrast researchers with policy-makers (e.g., Newman et al., 2016), researchers with teachers (e.g., Neal et al., 2019), or policy-makers with teachers (e.g., Mills et al., 2020). This already suggests that it may not be a "two-" community but a "three-or-more-" communities framework if we further include parents or students.

In addition, several scholars have stressed theoretical and empirical limitations of categorizing researchers and teachers as two distinct communities with regards to the research-practice gap (Jeune et al., 2024; Knight, 2024; Neal et al., 2019; Newman et al., 2016). For instance, Neal and colleagues (2019) revealed that there

are differences within members of the same community, with regards to their opinions and expectations about research. Categorizing teachers and researchers as two distinct communities may not be accurate and should be rather treated as a continuum. Jeune and colleagues (2024) showed that different educational stakeholders, including researchers and teachers, do not differ much regarding their perceptions on the factors influencing teachers' use of research.

The two-communities framework remains useful anyway (e.g., Farley-Ripple et al., 2018; Mills et al., 2020; Sjölund et al., 2023). For instance it is used by Farley-Ripple and colleagues (2018) who developed a conceptual framework representing the gap between teachers and researchers as a two-way problem (Tseng et al., 2017). They argue that "the cultures, contexts, and systems in which researchers and practitioners operate, including institutional goals and professional norms and expectations, differ significantly" (Farley-Ripple et al., 2018, p. 3). The nature and extent of such differences are still debated, and there is a particular need for in-depth research to better understand contextual differences between teachers and researchers (Vanderlinde & van Braak, 2010).

1.2 Collaborative research to bridge the research-practice gap

In order to bridge the gap between research and practice, various solutions have been developed in which the collaboration between both communities, linking the production and use of research, is central (e.g., Farley-Ripple et al., 2018; Jeune et al., chapter 3). A detailed literature review of the various models of collaborative research is beyond the scope of the current article. Jeune and colleagues (chapter 2) reviewed frameworks to study teachers' use of research, and many research point towards the relevance of brokers, or intermediaries, with solid knowledge of both research and teaching communities (Farrell et al., 2022; Knight, 2024; Rechsteiner et al., 2023; Rycroft-Smith, 2022), research-practice partnerships in which both communities would work towards mutually beneficial goals (Cooper et al., 2020; Farrell et al., 2022; Sjölund et al., 2023) and all sorts of collaborative approaches to research (e.g., Sanchez & Monod-Ansaldi, 2015) in which teachers and researchers contribute equally.

Brokerage has no consensual definition, but rather a variety of frameworks detailed by Rechsteiner and colleagues (2023). For the purposes of this article, following Rycroft-Smith (2023), we consider it equivalent to knowledge brokering and knowledge mobilization. By brokerage we mean the relational work conducted

by individuals or organizations to link research and teaching communities, both in terms of improving the understanding of each other's culture and system, but also facilitating knowledge exchange between educational stakeholders.

Research-practice partnerships are usually defined as “Long-term, mutualistic collaborations between practitioners and researchers that are intentionally organized to investigate problems of practice and solutions for improving district outcomes” (Coburn et al., 2013, p. 2). Echoing calls for more critical work in this field (Doucet, 2019; Tseng, 2022), recent work suggests that these partnerships should be equity-focused (Vetter et al., 2022), i.e. aiming at reducing differences across students on any educational outcome (not only school performance), and considering minorities’ needs.

Collaborative research methods include action research (Corey, 1954) or participatory action research (Kindon et al., 2007). The former aims at involving practitioners in doing research to improve their practices, and the latter focuses on challenging power relations with regards to who produces research. Other collaborative research include different approaches to teacher research (Cochran-Smith & Lytle, 1999), in which various goals, such as finding local solutions, social justice achievement or formalizing practical knowledge, could co-exist with different balances. Mixed approaches such as teacher participatory action research (Stapleton, 2018) include an explicit political orientation and teacher- and marginalized populations-focused design. Other methods include design research which aim to develop “theoretical insights and practical solutions simultaneously, in the real world [...], together with stakeholders” (McKenney & Reeves, 2012, p. 7) or design-based research in which the collaboration between researchers and teachers is central, teachers being co-participants and not subjects of the research, and all collaborators being in a mutual learning process (Sanchez & Monod-Ansaldi, 2015).

Other models, frameworks and approaches could be cited, with specific epistemological and political orientations, and most of them address the research-practice gap as a two way problem (Farley-Ripple et al., 2018; Tseng, 2022). First, the collaboration should include both teachers and researchers in the definition of the goals, of the practical problems to solve, of the design of the research, towards the joined creation of new, original knowledge (Atal et al., 2022; Farley-Ripple et al., 2018; Jeune et al., chapter 3; Sanchez & Monod-Ansaldi, 2015;) Second, the collaboration should be documented, both for other teachers and

researchers to benefit from lessons learned regarding the processes and outcomes of the collaborative research. Both process and outcomes should be mutually beneficial for the generated knowledge to be useful for both communities. Third, and maybe most importantly, collaboration needs structural support. It includes dedicated time allocated for both researchers and teachers, which means that the collaboration is not an additional burden. Such time could be used for collaborative work but also visits to each others' workplace to build trust and mutual understanding so that cultural change may happen. Fourth, the roles of researchers and teachers should be negotiated and explicitly defined (Sjölund et al., 2023; Sjölund, 2023).

While most of these considerations are included in the frameworks for research-practice partnership or design-based research, there is still a need to better understand how they are implemented in specific contexts. As most projects depend on the implication of a limited number of highly engaged people (both researchers and teachers, or even other educational stakeholders), it is crucial to understand what motivates them.

1.3 Teachers' motivations to engage in collaborative research

Teachers are overburdened (Ulla et al., 2017) and their work is not valued in society (OCDE, 2020). In these conditions, it is all the more puzzling that some teachers may want to collaborate with researchers, who have a different culture. Furthermore, teachers in France, where the current study takes place, report among the lowest collaborative school culture according to the Teaching and Learning International Survey (OCDE, 2020).

Previous studies on teachers' motivations to engage in collaborative research suggests that several factors at the individual level affects teachers motivations, among which that research self-efficacy and confidence (Landicho, 2020; Ulla et al., 2017; Yuan et al., 2016), perceived usefulness of the research produced (Landicho, 2020; Yuan et al., 2016), and positive attitudes towards research (Landicho, 2020; Ulla et al., 2017). In addition, the external factors such as external support from leaders or the institution (Landicho, 2020; Yuan et al., 2016), more time available for such collaborations (Landicho, 2020; Ulla et al., 2017) or financial support (Ulla et al., 2017) can all play a role in teachers' motivation to conduct research. Building upon the existing literature, Thi My (2018) categorized teachers' motivations to engage in research according to 4 categories: (1) self-efficacy beliefs (regarding

teachers' skills and legitimacy to conduct research), (2) context beliefs (regarding the importance of goal clarity, autonomy in conducting research, necessary time and time-span of the involvement), (3) attitudes towards research (perceived usefulness, expected difficulty or stress, and expected pleasure and interest) and (4) source of motivation (intrinsic or extrinsic motivation to conduct research).

While here we focused on teachers' motivations to join collaborative research projects, little is known about researchers' motivations. Studies interested in researchers' motivations focus on collaborations among researchers (Bond, 2021; Hückstädt, 2023; Rossi, 2016), not with teachers. However, it is crucial to understand "how different partners are motivated and incentivized to engage with one another [as part of collaborative research]" (Coburn et al., 2020, p. 8). Our study aims at describing teachers' and researchers' motivations to collaborate. By looking into the differences and similarities of their respective motivations, our study also aims at challenging the 'two communities' framework with empirical data.

1.4 Context of the study and research questions

Our research stems from a design-based research project which aimed at co-creating, with teachers and researchers, a research-brokered resource for teaching critical thinking, reported in another study (Jeune et al., chapter 3). The study took place between 2022 and 2024 and included three steps in which each researcher and teacher invited could participate (Figure 1) with different degrees of implication:

- Step 1 - Reviewing and suggesting changes: in this step, participants were asked to conduct a review of a previously existing research-based (but not research-brokered) resource. This review was done independently and in autonomy by each participant.
- Step 2 - Teacher-research workshops to illustrate the ressource with concrete examples: in this step, participants were invited to join regular online 2-hour workshops following a methodology based on collaborative teaching research (Atal et al., 2022). During the workshops, participants were guided to collaborate with each other to write concrete examples to illustrate the research-brokered resource;

- Step 3 - Sorting and prioritizing the suggested changes from the review process: participants were invited to join one-day, in-person meetings to collaboratively sort and prioritize the changes suggested from the review process (Step 1).

The current study is an exploratory case-study of teachers and researchers' motivations to collaborate in the different steps of this design-based research project. Our research questions are:

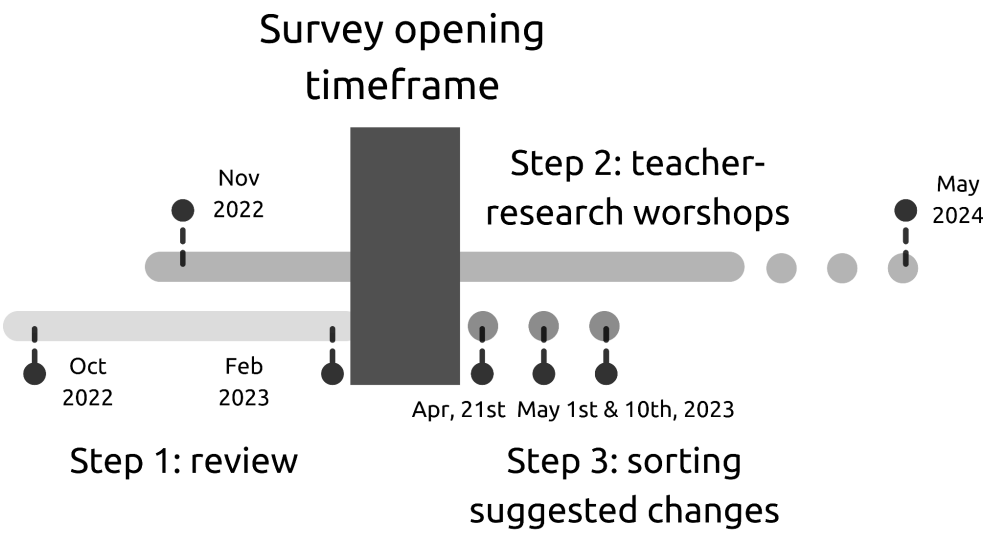
- What motivates teachers and researchers to engage in collaborative research projects?
- What are the differences between teachers' and researchers' motivations to engage in collaborative research projects?
- To what extent teachers' and researchers' motivations are linked to their engagement in the different steps of our design-based research project?

2. Method

We surveyed researchers' and teachers' motivations to engage in collaborative research in the context of our multi-step design-based research project. Our survey was inspired by the questionnaires used by (Thi My, 2018). The survey was administered during a one month timeframe at the end of step 1, during step 2, and before step 3 (Figure 1). We sent the survey to participants of the first step as well as active members of the network (step 2) and other teachers and researchers who had signaled their interest in participating in the review of the initial resource (step 1) but had not participated. The survey had two goals: answer our research questions and inform the organization of the in-person meetings conducted in step 3.

Figure 1.

Timeline of the research process and administration of the survey.



2.1 Participants

We recruited participants during events, through social media and personal contacts in our networks of researchers and teachers. Participants in this study include teachers and researchers who mentioned their interest to participate in any of the steps of the design-based research project, regardless of their actual participation. A teacher doing a PhD was categorized as both teacher and researcher.

The participation in the review (step 1) was rated ‘High’, or ‘Low’ depending on the comprehensiveness of their review and related suggested changes, while ‘No’ indicated that respondents did not participate in the review. The participation in teacher-research workshops was counted for each respondent, 0 indicating that they never participated. The participation in in-person meetings was counted for each of the three meetings, so that any respondent could have participated in 0 to 3 meetings, 0 indicating that they didn’t participate in any meeting.

Table 1 below describes the respondents in relation to their participation in the different steps of the design-based research project.

Table 1.

Participants' engagement in the design-based research project.

		Teachers (n=14)	Researchers (n=15)	Both (n=1)	Total (n=30)
Participation to step 1 - Degree of reviewing and suggesting changes	High	7	7	0	14
	Low	5	3	1	9
	No	2	5	0	7
Participation to step 2 - Number of teacher-research on-line workshops participated	9-12	2	0	1	3
	5-8	0	0	0	0
	1-4	5	0	0	5
	0	7	15	0	22
Participation to step 3 - Number of in-person meetings participated	2	1	1	0	2
	1	6	4	1	11
	0	7	10	0	17

2.2 Survey construction

We used LimeSurvey software to create the survey. Our survey was inspired by Thi My's (2018) questionnaire on teachers' motivations related to their engagement in research. In particular, her questionnaire address the following items:

1. Self-efficacy beliefs, which are operationalized by a reported degree of confidence in completing several research-related tasks.
2. Beliefs related to the influence of the research context. This scale aims to capture two complementary pieces of information: how much respondents agree or disagree (via a likert scale) that each item can contribute to increasing one's engagement in research, and the likelihood (via another likert scale) that this item is present in respondents' professional context.

3. Teacher attitude toward research, which is operationalized as ratings on a likert scale of agreement with various statements related to perceived usefulness of research, research anxiety, and positive predispositions toward research.

4. Teachers' motivation to participate in research, composed of both self-determined and non-self-determined motivation.

5. Finally, her questionnaire includes a section that addresses teachers' engagement in research.

In her work, Thi My (2018) used teacher engagement in research as the dependent variable, and the 5 variables associated with the 4 previous sections as independent variables.

We adapted her survey for the purposes of our research. After collecting informations about the participants (name, email, how they have heard about the research project), our survey included the following four sections:

- perception of engagement in research in general;

- perception of engagement in the review process (step 1), which ended just before they responded ;

- perception of engagement in teacher-research workshops (step 2), which were ongoing at the time of response;

- perception of engagement in the on–day in-person meetings to sort and prioritize the changes suggested from the review (step 3), which were scheduled after the survey.

Each of these four sections started with a similar prompt to give the context of the section, and included 10 statements on which participants had to position themselves following a 7-point symmetrical likert scale (from -3 'strongly disagree' to '3 'strongly agree'). A 7-point likert scale was chosen to avoid skewed results (Cohen et al., 2018) and displayed in a matrix to take less space (id.). Reliability was maximized by wording all statements positively (Weems et al., 2003). We then added an open-ended question after each section. In addition to the initial information about participants, the survey thus included 40 likert-based questions and 4 open-ended questions. The statements were organized into four categories which were inspired by Thi My's (2018) work, in which each category originally

consisted of a specific questionnaire. The statements chosen within each category corresponded to subcategories of the scales used by Thi My. We thus included in the survey 1 statement related to Self-efficacy beliefs; 4 statements related to Context beliefs; 3 statements related to Teacher attitude toward research; and 2 statements related to teachers' motivations to do research. While Thi My's (2018) work focused on teachers, we have written each statement so that it could be adapted for both teachers and researchers. The 10 statements used in the first section of our survey are described in table 2.

Table 2.

List of statements used in the survey.

Category	Statements used
Self-efficacy beliefs	I need to feel I have the necessary skills and that I am legitimate to take part in these steps of the research project.
Context beliefs	The purpose and objectives of my participation in these steps of the research project should be clear and precise.
	The time I must take to participate in these steps of the research project should be reasonably short.
	The period of time over which I can participate in these steps of the research project should be long enough.
	I need to be able to choose the times when I collaborate and when I work independently in these steps of the research project.
Participants' attitude towards research	I need to be able to use the results of the project, or what I learn from taking part in these steps of the research project.
	My participation in these steps of the research project should not be difficult or stressful.
	My participation in these steps of the research project should be pleasant or interesting.

Participants' motivations to do research	My participation in these steps of the research project should come from personal motivation (e.g. an interest in the subject).
	My participation in these steps of the research project should come from external motivations (e.g. a reward or obligations linked to my job).

In order to facilitate the comparison between responses, we have chosen to keep the wording consistent between the different statements and across sections, despite the fact that each section was related to a step of the collaborative research process with a different time reference. Indeed, the first section asked participants about their motivations to engage in collaborative research in general, the second about the past review, the third about the ongoing workshops, and the fourth about future in-person meetings. Whenever relevant, the phrasing of the statements were inclusive of all respondents whether they had already engaged in a given research step or not. In other cases (sections relative to step 1 and 2), the use of the verb "need" or "should" was replaced by "seems to me". Finally, in the last section (relative to step 3), we replaced four statements to capture elements needed to organize the one-day meetings. These four items were excluded from the analyses. In Table 3 are represented two examples of statements with phrasings differing across sections.

Table 3.

Examples of different phrasings in our motivation to engage in collaborative research survey.

Section	Example of phrasing across sections
Motivation for engaging in collaborative research in general	The purpose and objectives of my participation in these steps of the research project should be clear and precise.
	I need to be able to use the results of the project, or what I learn from taking part in these steps of the research project.
Motivation for engaging in the review process (step 1)	I think the aim and objectives of this step of the research project were clear and precise.

	I think that the outcome of the project or what I learned during my contribution to this step of the research project was (or would have been) useful to me.
Motivation for engaging in Teacher-research workshops (step 2)	I think the aim and objectives of this step of the research project are clear and precise.
	I think that the outcome of the project or what I learned during my contribution to this step of the research project could be useful to me.
Motivation for engaging in one-day meetings (step 3)	To determine whether I will participate in a meeting on rewriting recommendations, it is important to me that the aim and objectives of my participation are clear and precise.
	To determine whether I will participate in a meeting on rewriting recommendations, it is important to me that the outcome of the meeting or what I will learn from my participation will be useful to me.

The order of statements displayed to respondents was randomized within each section, but the orders of sections were not. We did not account for the effect of the sections' order as this study is exploratory. The english translation of the complete survey can be found in appendix 7.

2.3 Analysis plan

We put in a database the informations related to each participant, namely their role, the extent of their participation to the review of the initial resource (step 1), the number of Teacher-research workshops in which they participated (step 2) and the number of in-person meetings to sort the suggested changes from the review step (step 3), as well as their answers to the survey questions. We will now describe the analyses conducted to answer each of our research questions. We used R software (v. 4.1.3) to conduct the analyses. All the annotated code can be found in appendix 8. In addition to multivariate analyses we conducted throughout this study, we reported several univariate analyses as an exploratory step to inform future research.

2.3.1 Participants motivations to engage in collaborative research projects

Our first research question was “What motivates teachers and researchers to engage in collaborative research projects?”. In order to better describe our results, we first used histograms to illustrate the answers to each statement of the questionnaire, ordered by their means and displaying the standard deviation for each item. Histograms were produced separately for answers to each of the sections of the questionnaire (motivations to engage in collaborative research in general, and motivations to engage in each of the steps of our design-based research).

To compare the ordered means of the responses to the statements within each section we conducted an univariate analysis with the lm() function. We displayed on the histograms the most relevant statistically significant differences between statements. We finally compared the relative importance of each of the sources of motivation between the sections, as some specific steps of the collaborative research may be perceived as more or less motivating.

As an additional description of our results, we used the cov() function to create a covariance matrix including all responses from each of the four sections of the questionnaire. Based on this covariance matrix, we judged whether the variances are globally homogeneous. When this was the case, we have produced an easier to read and mostly equivalent correlation matrix (fixing all variances to 1) using the cor() function. Whenever necessary, we have indicated the items whose variance was strongly different from 1, and as such which should be interpreted with caution in the correlation matrix.

To better describe the links between similar items across all sections, we similarly created covariance and correlation matrices for each theoretically related item (e.g., a statement about self-efficacy beliefs appears in each section, therefore a covariance and correlation matrix with the responses to self-efficacy beliefs within each of the four sections have been created).

2.3.2 Differences between teachers’ and researchers’ motivations

Our second research question was “What are the differences between teachers’ and researchers’ motivations related to their engagement in collaborative research projects?”. In order to better describe our results, we first used histograms similar to those used to answer the first research question, but we instead separated the

answers from teachers and those from researchers. We excluded the participant who plays both roles to facilitate the analyses.

To assess whether the motivations of teachers and researchers differed, we conducted a multivariate analysis with the Manova() function with Pillai statistical test, treating together all answers of each of our four sections separately. We judged the multivariate analyses to be relevant as, by design of the different items from each section, we expected them to be related.

To explore which of the statements had the most explanatory power, we conducted a principal component analysis (PCA) using the pca() function from the FactoMineR package v. 2.11 (Lê et al., 2008) on the answers to each of the four sections. As a qualitative analysis we will aggregate the first component of each PCA in a single table and look at the items which seem to play an important role in each of the four sections. We will then use them as the basis of a restricted multivariate analysis. Even though the first component may explain a limited percentage of the total variance, we will interpret the findings according to the research question, in reference to the shortlisted items that have the most potential.

2.3.3 Link between respondents' motivations and their actual participation

Our third research question was "To what extent teachers' and researchers' motivations are linked to their engagement in the different steps of our design-based research project?". In order to answer this question, we needed to differentiate two cases: one case in which participation happened before the survey was sent (steps 1 and 2), and another case in which participation happened after the survey was sent (step 3).

The first case includes participants' motivations to join the review of the resource (step 1), and the Teacher-research workshops (step 2). In fact, as these steps both started before the participants answered the survey, the participation to the review and to the teacher-research workshops had to be treated as the independent variables possibly explaining the survey responses (dependent variables). To assess to what extent participants engagement in the review process (step 1) predicts their motivations to join such a review process, we conducted a multivariate analysis with the Manova() function with Pillai statistical test using as predictors respondents' participation to the review step (no, low or high), and as outcome participants' responses to the corresponding section of the motivations' survey. Similarly, we used the number of Teacher-research workshops in which they

participated (discrete numbers from 0 to 14) to predict participants' motivations to join such a step as collected in the corresponding section of the motivations' survey.

The second case includes the participation in the in-person meetings (step 3). In that case, the participants answered the survey before they could participate in these workshops, and thus the responses to the corresponding section of the survey were treated as the independent variable possibly explaining their actual participation to these meetings (dependent variable). To assess to what extent participants' motivations could explain their participation in step 3, we conducted an univariate ordinal regression using the polr() function from the MASS package v7.3-61 (Ripley et al., 2024) in relation to the last section of the questionnaire (step 3). This test was adapted to this situation because there is a unique dependent variable: the participation in any number of in-person meetings (discrete numbers from 0 to 2). We performed an ordinal regression because of the low number of different values taken by our dependent variable.

2.3.4 Missing values

In the sections of the survey regarding the steps 1, 2 and 3 of the design-based research projects, we added an option 'I don't know' to the likert scale responses. These answers have been treated as missing data. After verification of that these missing values could be considered as missing completely at random, we used the MissForest function for non-parametric missing value imputation for mixed-type data (Stekhoven & Bühlmann, 2012) from the missforest v 1.5 package (Stekhoven, 2022). This allowed us to artificially replace the missing values with ordinal values in the range of our likert scale, without affecting the global distribution of the result. All subsequent analyses were performed with the original data, including missing values, and with complete data where missing values had been replaced by artificial values. Unless otherwise mentioned when significant differences between analyses of both datasets, all results reported originate from the dataset with artificial values.

3. Results

We used different variable names in the code for each of the 10 statements, all of which can be found at the beginning of the code (appendix 8). In the table below, we show the translation and correspondence for each statement related to the first section (motivations to engage in collaborative research in general). The

statements are similar in the other three sections, and their translation can otherwise be found in the appendix 7.

Table 4.

Correspondence between acronyms used and survey statements in the first section.

Comp	I need to feel I have the necessary skills and legitimacy to take part in these steps of the research project.
Goal	The purpose and objectives of my participation in these steps of the research project must be clear and precise.
Shor	The time I need to take part in these steps of the research project must be sufficiently short.
Dura	The period of time over which the opportunity to participate in these steps of the research project is extended must be sufficiently long.
Auto	I need to be able to choose when I collaborate and when I work independently in these steps of the research project.
Usef	The results of the project, or what I learn during my participation in these steps of the research project, should be useful to me.
Stre	My participation in these steps of the research project should not be difficult or stressful.
Nice	My participation in these steps of the research project must be pleasant or interesting.
Intr	My participation in these steps of the research project must come from personal motivation (e.g. an interest in the subject).
Extr	My participation in these steps of the research project must come from external motivations (e.g. a reward or obligations related to my job).

3.1 Participants motivations to engage in collaborative research projects

The figures 2 to 5 below are histograms which respectively correspond to the ordered mean and standard deviation of the responses to the items to each section

of the questionnaire. The likert scale varied from -3 to +3, and most of the answers were positive, indicating that the items did correspond to a motivation source. For instance, concerning participants' motivations to join research projects in general, participants consistently rated high the item 'Nice' (participation in collaborative research activities should be pleasant or interesting). Excluding the participant with both roles overall did not change the significance of the results.

Figure 2.

Participants' motivations to engage in collaborative research projects in general.

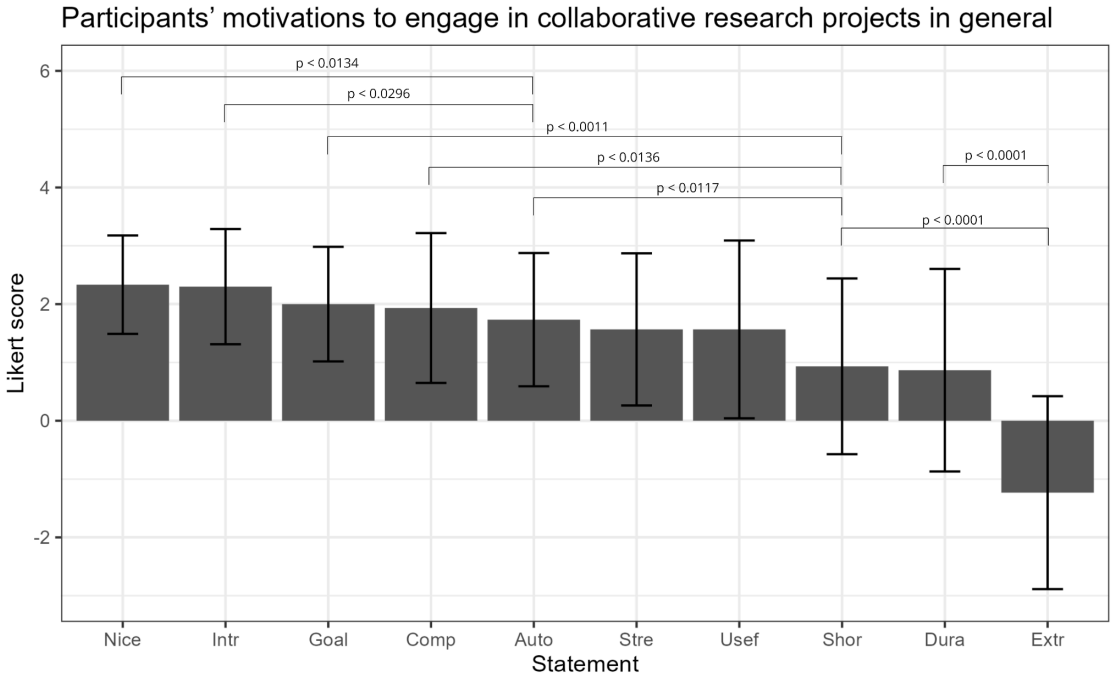


Figure 3.

Participants' motivations to engage in the review process (Step 1 of the design-based research).

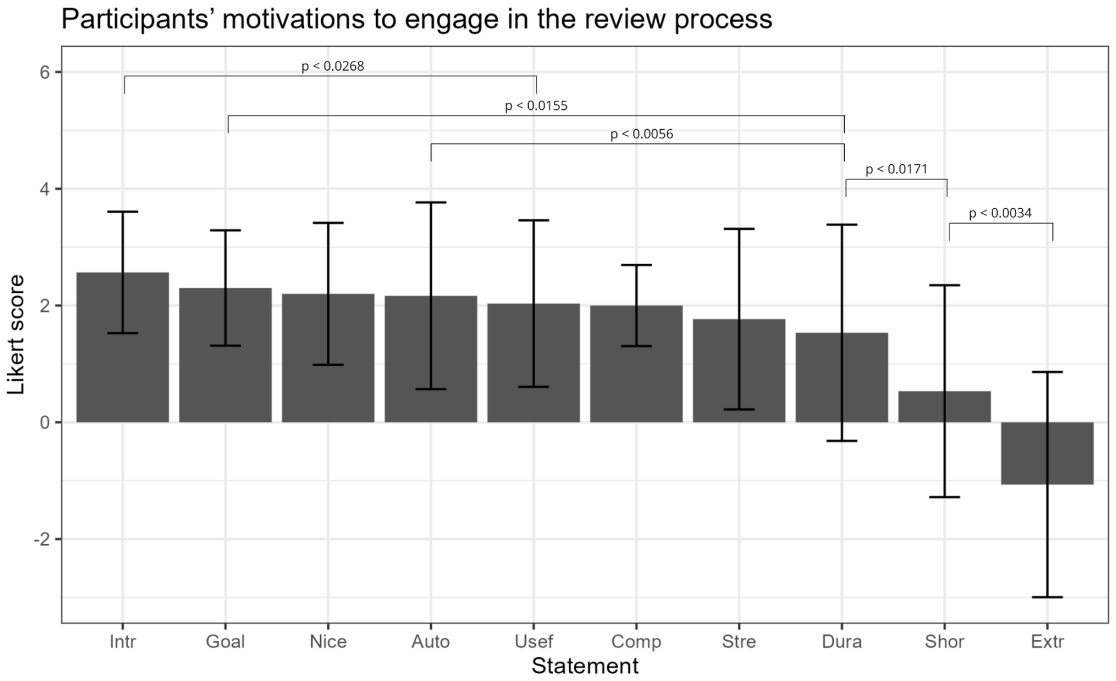


Figure 4.

Participants' motivations to engage in the teacher-research workshops (Step 2 of the design-based research).

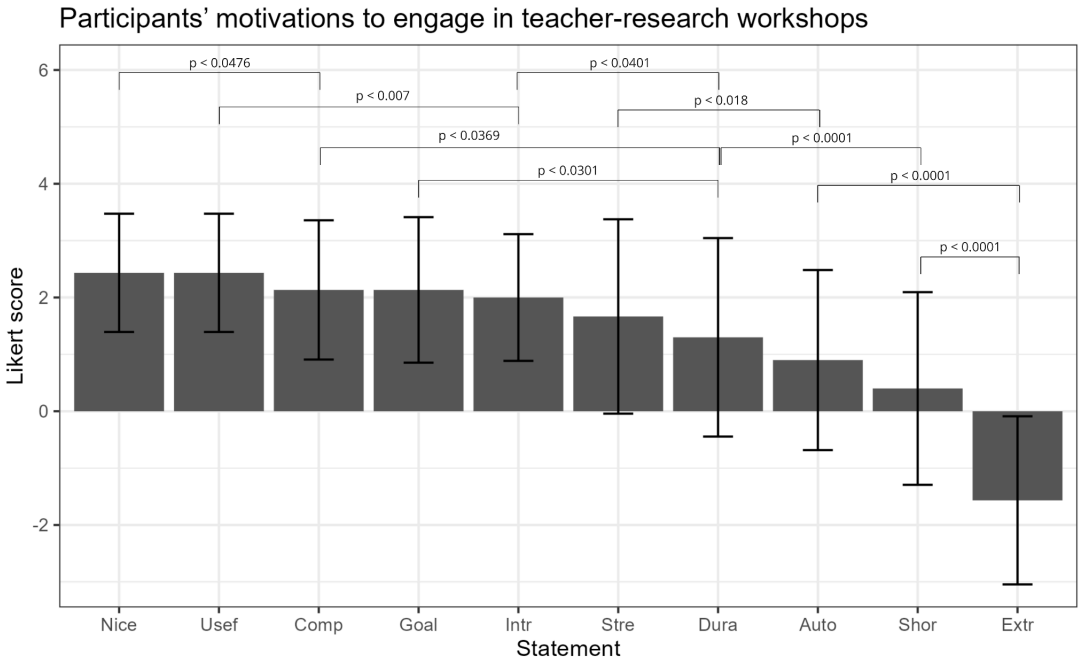
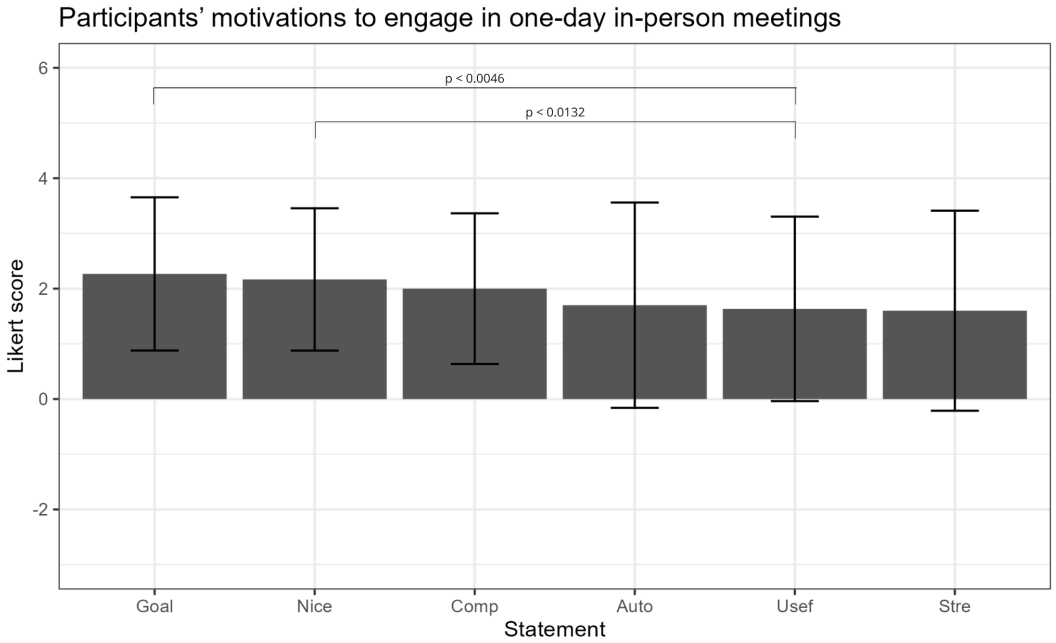


Figure 5.

Participants' motivations to engage with the one-day in-person meeting (Step 3 of the design-based research).



The histogram related to the first section (figure 2) regarding participants' motivations to engage in collaborative research projects in general shows that Nice ('My participation in these steps of the research project must be pleasant or interesting'), Intr ('My participation in these steps of the research project must come from personal motivation'), Goal ('The purpose and objectives of my participation in these steps of the research project must be clear and precise') and Comp ('I need to feel I have the necessary skills and legitimacy to take part in these steps of the research project') are the four highest rated motivation sources, while not statistically significantly different from each other.

The histogram related to the second section (figure 3) regarding participants' motivations to engage in the review process (step 1), shows that Intr, Goal, Nice and Auto ('I need to be able to choose when I collaborate and when I work independently in these steps of the research project') are the four highest rated motivation sources, while not statistically significantly different from each other.

The histogram related to the third section (figure 4) regarding participants' motivations to engage with the Teacher-research workshops (step 2), shows that Nice, Usef ('The results of the project, or what I learn during my participation in these steps of the research project, should be useful to me'), Comp and Goal are

the four highest rated motivation sources, while most are not statistically significantly different from each other.

The histogram related to the fourth section (figure 5) regarding participants' motivations to engage with the one-day in-person meeting (step 3), shows that Goal, Nice, Comp and Auto are the four highest rated motivation sources, while not statistically significantly different from each other.

The analysis of the difference between items tends to indicate, based on the first three sections of the survey, that the statements related to Dura ('The period of time over which the opportunity to participate in these steps of the research project is extended must be sufficiently long'), Shor ('The time I need to take part in these steps of the research project must be sufficiently short') and Extr ('My participation in these steps of the research project must come from external motivations (e.g. a reward or obligations related to my job)') – especially the last two – appear as lower sources of motivation than the others. In particular, the only statement with a negative rating is related to the influence of external motivation, which therefore appears as no source of motivation at all. Because of the skewed nature of the data (most of the responses are higher that 2 in a -3 to 3 scale), due to our small sample size, it is not reasonable to extrapolate the findings as to which elements are the most motivating.

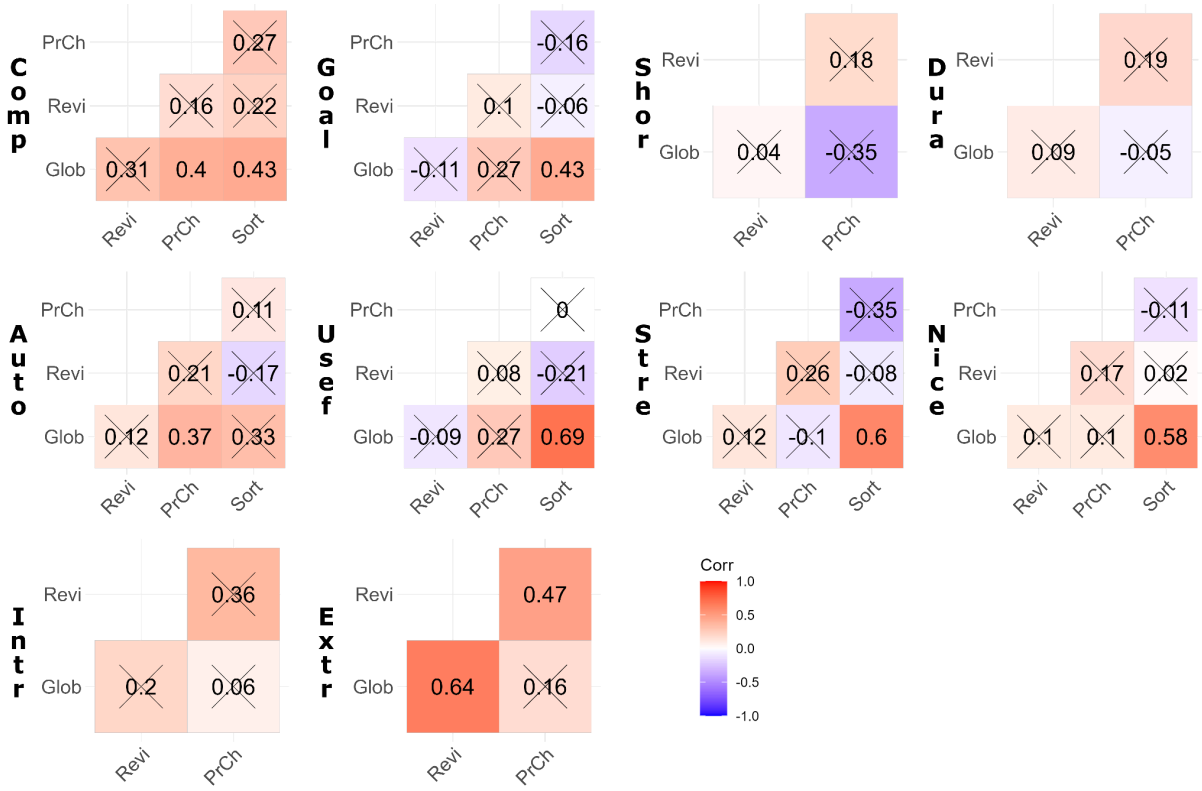
In addition, the variance/covariance matrices indicated that there was most of the time a higher variability in the three lowest rated statements and a lower variability in to three highest rated statements. This could be due to the upper limit of the likert scale which was hit more often, whereas the lower rated statements were on average closer to 0, indicating more diverse ratings. It is notable that the Comp ('I need to feel I have the necessary skills and legitimacy to take part in these steps of the research project') statement in the section related to the review (step 1) had an extremely low variability as compared to the others, and the reasons for that should be explored further.

The correlation matrices (appendix 9) between similar items across the four sections (Figure 6) indicated that, in general, despite the choice of similar wording for the items, they are rarely significantly correlated. Unless this result is due to methodological errors, this could indicate that the actual motivations of each participant could differ depending on the specific nature of the different steps of the design-based research process. While most of the correlations are not

statistically significant, it is noticeable that most of the statistically significant correlations between several items are between the motivations to engage in collaborative research in general, and the motivations to engage in the one-day meetings (Step 3). This could be due to the fact that the one-day meetings have not happened before the survey was delivered, which is closer to the abstract situation of participants' motivations to engage in collaborative research in general. With regards to the two other sections (concerning Steps 1 and 2), most participants have already lived the corresponding steps, and their motivations sources may be influenced by their actual participation.

Figure 6.

Correlation matrices of each item across the three or four sections.

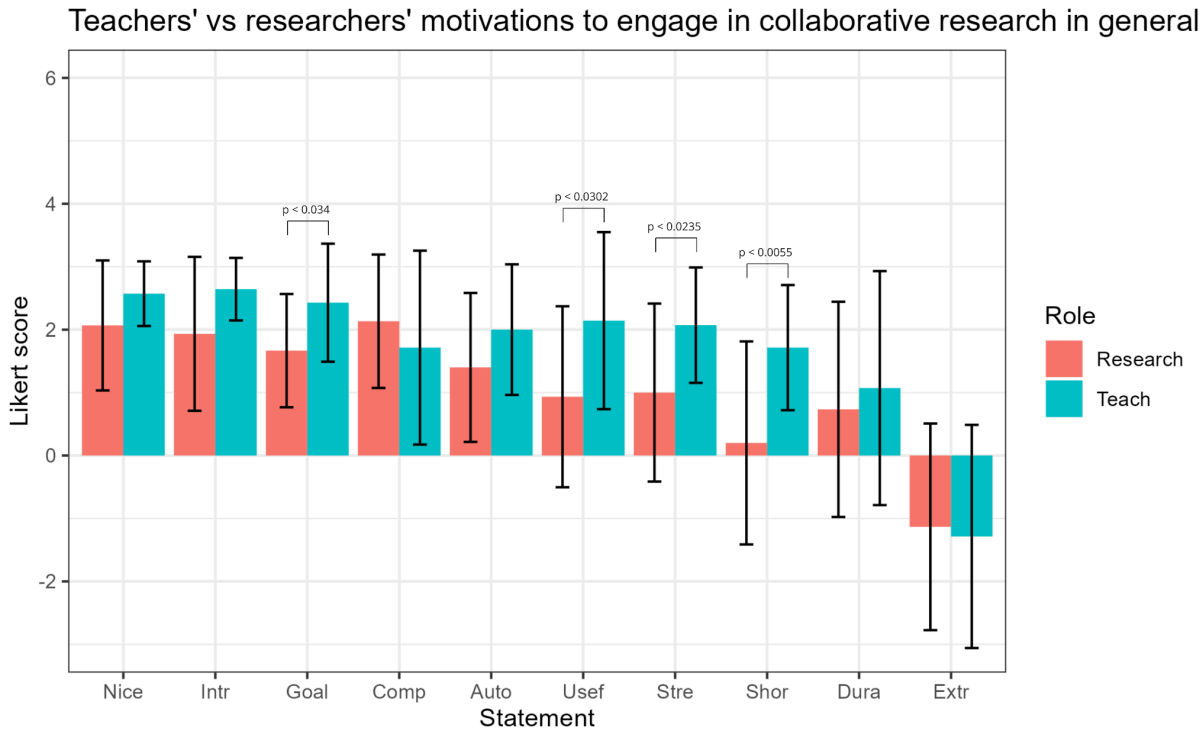


3.2 Differences between teachers' and researchers' motivations

The role of the respondent (teacher or researcher) did not have a statistically significant effect on their motivations to engage in collaborative research in general ($p = 0.067$). Nonetheless, we indicate item by item the statistical significance of the difference between teachers' and researchers' responses to the first section (motivations to engage in collaborative research in general) on the histogram (Figure 7).

Figure 7.

Role differences related to participants' motivations to engage in collaborative research projects in general.



The role of the respondent (teacher or researcher) did not have a statistically significant effect on their motivations to engage in any of the three steps of our design-based research project (p = 0.918, p = 0.3113 and p = 0.2786 respectively). The only statistically significant differences between roles about specific statements were reported on the other histograms (appendix 10).

Interestingly, for all rare cases in which we found statistically significant differences between both roles, teachers rated these items higher than researchers, which means that these items were judged as more motivating than for researchers. The statements related to Goal (clear purpose and objectives) and Stre (not difficult or stressful) have been rated differently by teachers and researchers in the first section (motivations to engage in collaborative research in general) as well as the last section (motivation to participate in the one-day meetings, step 3). The statements Usef ('The results of the project, or what I learn during my participation in these steps of the research project, should be useful to me') and Shor ('The time I need to take part in these steps of the research project must be sufficiently short') were also rated differently by teachers and researcher in the first section. This could indicate that teachers are more motivated if the

goals are clear, and that the collaborative research is not stressful, and in some cases, it could be more motivating for teachers than for researchers when the collaboration takes limited time and that the result or the learning is useful for themselves.

In our principal component analysis the first component always accounted for at least 30% of the total variance for each of the four sections of the questionnaire. Within each section, each of the statements varied in their contributions to this first component (Appendix 11). A qualitative analysis of the values indicated that the Usef statements (useful result or learning for the respondent) played an important role in each section, and the Goal (clear purpose and objectives) and Nice (pleasant or interesting participation) items contributed in many sections. We thus decided to focus on these specific items to look for role differences with a multivariate analysis restricted to occurrences of these statements across all four sections. We almost found a statistically significant difference of rating between teachers and researchers when considering the Usef statement ('the results of the project, or what I learn during my participation in these steps of the research project, should be useful to me') alone ($p = 0.056$).

Overall, we found very limited role differences with regards to their motivations to engage in collaborative research. However, these results are hard to extrapolate because of the limited sample size and not necessarily representative sample. We cautiously conclude that the effect of the role (being a researcher or a teacher), when there is one, is most likely to be small and that other factors may contribute more to the motivations to participate in collaborative research.

3.3 Link between respondents' motivations and their actual participation

Concerning the review step (step 1), we found a significant link between respondents' participation in the review of the resource (step 1) and their a posteriori motivations to join such a step ($p < 0.0017$). Looking at the univariate analyses, the correlation between participation to the review was particularly associated with high ratings of Nice ($p < 0.001$), Auto, Dura ($p < 0.01$) and Shor ($p < 0.05$).

Concerning the second step, respondents' participation in the teacher-research workshops did not predict their a posteriori motivations to join these workshops ($p = 0.1343$).

We compared successive linear models to assess whether responses to the last section of the survey (motivation to participate in one-day meetings) predicts their participation in the in-person meetings (step 3). This analysis indicates that the answers to the statements Auto (‘To determine whether I'll be taking part in a meeting on rewriting recommendations, it's important for me to choose the times when I collaborate and when I work independently’) and Usef (‘To determine whether I'll be taking part in a meeting on rewriting recommendations, it's important for me that the results of the meeting or what I learn during my participation will be useful to me’) significantly predict respondents’ subsequent participation ($p < 0.01$ and $p < 0.05$ respectively).

Overall, our results suggest that different sources of motivation to participate in various steps of collaborative research can be linked to actual participation. As such, the motivation sources most correlated with actual participation, such as the usefulness of the result or process could be targeted in future research to maximize educational stakeholders’ engagement in collaborative research.

4. Discussion

In this work we studied teachers and researchers’ motivations to engage in collaborative research. Our study took place in the wider context of a design-based research project which aimed at collaboratively engaging a diverse range of researchers and teachers in order to produce a research-brokered resource for teachers about teaching critical thinking. This design-based research followed different steps: participants were invited to review an existing research-informed resource (step 1), they were invited to join on-line regular workshops to describe illustrative examples for the resource (step 2), and were invited to join three in-person one-day meetings to sort and prioritize the suggested changes from the review step (step 3). A final step not analyzed in this manuscript was the writing and the formatting of the final resource, mostly conducted by one member of the research team and described in another article (Jeune et al., chapter 3). To study participants’ motivations to join these different steps, we surveyed participants following Thi My’s (2018) framework of teacher engagement in research. The survey separately questioned participants’ motivations to join collaborative research projects in general, and their motivations to join each of the steps of the design-based research process.

Based on the data collected from 30 respondents, we found out that not all sources of motivation are perceived as equally important, and what motivates

teachers and researchers may be related to specific parts of the collaborative research participants are invited to join. This shows the importance of clarifying the specificities of each collaborative research project when studying participants' motivations. In addition, the sources of motivation from teachers versus researchers are quite similar, which contributes to the nuance of the "two-community" framework widely used in our field. Third, some sources of motivation appear to be more important predictors of actual participation than others, and should then be taken into account when designing collaborative research projects.

4.1 Participants motivations to engage in collaborative research projects

Our first research question was 'What motivates teachers and researchers to engage in collaborative research projects?'. We have found that regardless of the section of our survey, the extrinsic motivations (rewards or professional constraints) were judged as a minor source of motivation. Thus, our respondents judged that it did and would not play a significant role in their engagement in collaborative research. Similarly, but to a smaller extent, the time needed to participate in such collaborative research was not judged as a high source of motivation. This means that our respondents judged that even if it took them a long time to participate, they would still be motivated to do so. This is surprising with regards to previous literature, stressing the problem of lack of time for teachers (Anwaruddin, 2016; Cain; 2016; Dagenais et al., 2012; Gentaz & Richard, 2022; Goffin et al., 2022; Hemsley-Brown & Sharp, 2003; Jones et al., 2022; Penuel et al., 2020; Pereira & Fang, 2022; Sjölund et al., 2022). The possible reasons to explain this result are that on the one hand, our sample is not representative of most teachers and researchers. Most respondents did participate in our design-based research, and as such may on average be more engaged teachers and researchers than the norm, and thus be ready to spend more time than others. On the other hand, as our survey focused on motivation, respondents may have judged that (lack of) time was not affecting their motivation but rather the actual conditions for their participation. That is, some educational professionals could be highly motivated to participate in a collaborative research project, even though it would take time, but would end up not participating because they would not be able to spend that time, regardless of their high motivations.

Apart from these specific items, most of the items included in our survey were rated as important for respondents' motivation. We nonetheless suggest a cautious interpretation of the graphs, as the answers to the different sections may be influenced by the answers to previous sections. In addition, our limited statistical power may not allow us to draw precise conclusions about the respective weight of the items. Our research still suggests many avenues to bridge the research-practice gap (Crain-Dorough & Elder, 2021; Joyce & Cartwright, 2020; Knight, 2024; Neal et al., 2019) by creating motivating collaborative research settings. For instance, it seems important to make sure that the participants find the collaboration pleasant. Our results also echoes many recommendations regarding the importance of taking time to build mutual trust between teachers and researchers and develop appropriate skills (Dagenais et al., 2012; Penuel et al., 2020; Rechsteiner et al., 2023; Vetter et al., 2022).

The overall low correlation between items with similar wordings across all four sections is interesting, because it may indicate that the motivations to participate are highly sensitive to the specific nature and context of the collaboration (e.g. participating in regular on-line workshops versus participating in once during a one-day meeting). While much research tries to generalize results, our work might instead point towards the importance of local factors which may influence educational stakeholders' participation in collaborative research. This is consistent with Sanchez and colleagues (2017) calling for more detailed information on how design-based research projects unfold.

4.2 Differences between teachers' and researchers' motivations

Our second research question was 'What are the differences between teachers' and researchers' motivations related to their engagement in research projects?'. We have found that, overall, teachers' and researchers' did not differ much regarding their motivations to join collaborative research in general nor any of the steps of our design-based research. While our limited statistical power does not allow us to conclude on the sole basis of our exploratory study, our work may contribute to nuance the 'two communities framework' (Crain-Dorough & Elder, 2021; Sjölund et al., 2023; Taylor et al., 2023) as both teachers and researchers in our sample seem to share most of the same motivations. This does clearly not invalidate the framework itself, and as several researchers pointed out, it is useful even though it can be criticized (Farley-Ripple et al., 2018; Mills et al., 2020; Sjölund et al., 2023). It is nonetheless interesting to see that, in our study, teachers rated most items

higher than researchers. This could be explained by many elements, for instance the specificity of our sample of respondents. We could also interpret such a difference simply by a potential tendency to answer likert scales, in which teachers may more often than researchers choose the extreme options. That being said, future research on the role differences may contribute to shed light on this topic, but it is likely that role differences, when they are found, remain small and that future frameworks may benefit from moving beyond the simple two-communities framework towards a continuum.

In addition, we found that the perceived usefulness of the collaborative research played an important role in participants' motivations. Usefulness could be linked to research aiming at facilitating teachers' use of research, such as the one identified by Dagenais and colleagues (2012), or Rycroft-Smith (2022). More research could be devoted to understanding what contributes to usefulness from teachers' and researchers' perspectives. Possibly emerging differences could then be discussed in relation to the two-communities framework. For instance, researchers could find collaborative research useful because they can access otherwise inaccessible data from teachers collaborating with them, whereas teachers could find researchers' expertise on a very specific topic helpful, and contribute to their professional development. But these collaborations could also be perceived as useful on a more political level, with researchers and teachers sharing a common social justice desire who would find useful to join forces to improve equity within schools through partnerships (e.g., Vetter et al., 2022)

4.3 Link between respondents' motivations and their actual participation

Our third research question was 'To what extent teachers' and researchers' motivations are linked to their engagement in the different steps of our design-based research project?'. Our results indicate a strong link between the participation in the review of the resource (step 1) and participants' a posteriori motivations to join such a step of the design-based research. Participation in teacher-research workshops (step 2) was not correlated with their motivations to join such a step. This may be due to the specificity of this step which was ongoing at the moment of the survey responses. In addition, relatively few respondents had participated in the Teacher-research online workshops, most notably, only teachers had participated. Concerning step 3 (joining in-person meetings), participants' motivations with regards to their possibility to participate in autonomy and to the

perceived usefulness of the result or the process were significant predictors of actual participation. Autonomy was negatively associated while the perceived usefulness was positively associated with the participation. This means on the one hand that the less participants judged autonomy as an important source of motivation, the more likely they were to participate. On the other hand, the more participants judged perceived usefulness as an important source of motivation the more they were likely to participate.

Our results therefore suggest that our survey can be a valuable tool to better understand participants' motivations to participate in collaborative research projects, and to yield insights in order to predict participation. Future research could build on our findings and the survey design to try to achieve more participation from minorities, as is increasingly advocated for in the field of teachers' use and production of research (Doucet, 2019; Jeune et al., chapter 2; Jones et al., 2022; Tseng, 2022; Vetter et al., 2022).

4.4 Limitations

Our work has many limitations, the most obvious being the small sample size and lack of representativeness of our sample. We acknowledge that, and took necessary precautions in the interpretation of findings: our study was exploratory in nature, and as such we do not aim to generalize. Instead, we believe that our work provides food for thought and can help us generate precise hypotheses to be tested in future, larger scale research.

Our sample consisted mainly of teachers and researchers from our network. As such, they were most likely more motivated than the average, which could have influenced the results. It would be especially interesting to try to include a more diverse group of respondents in future research, and we hope that our exploratory study will set the ground for large scale collaborations to reproduce this study across various collaborative research contexts, and a wider range of participants.

Another limitation is due to the dual nature of our work: on the one hand, it is a research project and as such we aimed to contribute to theory and build knowledge, but on the other hand, the survey aimed at helping us organize better the in-person meetings so that we could best take respondents' options into account. Because of that, our survey had differently designed statements for the last section (step 3), making it more difficult to interpret our results. Nonetheless, the item-per-item analyses allowed us to identify specific sources of motivations

more important than others, differing depending on the nature of the collaborative step under scrutiny, and better predicting actual participation than others.

Finally, the design of our survey was extremely time-constrained due to the incoming in-person meetings, we did not build upon a single predefined motivation theoretical framework, something already frequent (Thi My, 2018). However, teachers' motivations was not central to our work, because our focus was more on the 'two-communities theory' (Caplan, 1979; Dwan et al., 2015; Jeune et al., 2024; Knight, 2024; Malin & Paralkar, 2018; Neal et al., 2019; Newman et al., 2016) and the research-practice gap (Crain-Dorough & Elder, 2021; Sjölund et al., 2023; Taylor et al., 2023). Nonetheless, future research should aim to link them with theoretical frameworks related to motivation.

4.5 Conclusion

Our exploratory study contributes to nuance the two-communities framework, while providing insights into the respective motivations of researchers and teachers to engage in collaborative research. This work opens the door to more research in order to test the robustness of our findings, and dig deeper into this topic.

We hope that our study can be both useful for researchers studying the collaborations between researchers and teachers, and their potential for improving teachers' use of research (Gorard et al., 2020) for instance as part of research-practice partnerships (e.g., Penuel et al., 2020, Sjölund et al., 2022). We also hope that it can be helpful for other educational stakeholders in finding inspiration as to which important levers can be used to improve the motivation of other educational stakeholders to collaborate.

Chapter 5: Teaching critical approaches. A conceptual framework to help teach and evaluate critical thinking.

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Abstract

This theoretical article addresses recurring issues with the conceptualization of critical thinking and their impact on teaching practices and evaluation. Our literature review reveals that most articles on teaching critical thinking emphasize skill development over dispositions and focus on the epistemic dimension of critical thinking, often neglecting its ethical and political dimensions. Furthermore, critical thinking is frequently evaluated through standardized testing, which is ill-suited for complex conceptions of critical thinking. In contrast, qualitative approaches offer a promising alternative. We also pinpoint limitations of evidence-based methods for evaluating teaching critical thinking and share concerns about their limitations related to the concept of transfer. We propose addressing the aforementioned pitfalls by introducing the concept of teaching critical approaches as an alternative to traditional methods of teaching critical thinking. Teaching critical approaches emphasize integrating both skills and dispositions, and incorporating epistemic, ethical, and political dimensions, for instance through working on socio-scientific issues. We advocate for collaborative research approaches to co-create evaluation tools and focus on the transversal mobilization of critical approaches rather than the transfer of critical thinking skills. As our teaching critical approaches concept stemmed from a design-based research project which created a research-brokered resource on teaching critical approaches, we finally describe how we operationalize this concept in the resource. It includes four chapters: relationship to knowledge; metacognition and reflexivity; argumentation; and information evaluation. Each chapter begins by identifying problematic approaches to teaching critical thinking, explaining the issues, and offering research-inspired teaching strategies as alternatives. We conclude by underscoring the importance of institutional support for the time-intensive frameworks needed for teaching critical approaches, which necessitate collaboration between teachers and researchers.

Teaching critical thinking is part of the missions assigned to teachers in many countries (Dominguez et al., 2018), but teachers rarely have a deep understanding of the concept of critical thinking (Yuan & Liao, 2023). Some views of critical thinking can even be opposed and incompatible: for instance, people who believe in conspiracy theories often claim being critical thinkers, while people debunking these conspiracy theories also claim being critical thinkers.

When it comes to teaching critical thinking, teachers' shallow understanding of that concept may have different implications. While it is widely acknowledged that content knowledge is necessary for any thinking to be critical (e.g., Lai, 2011; Willingham, 2008), it is far from sufficient. The critical thinking literature is clear about the importance of skills – "verbal reasoning, argument analysis, hypothesis testing, likelihood and uncertainty, decision making/problem solving" (Ku, 2009, p. 74) – and dispositions – "a person's consistent internal motivation to act toward, or to respond to, persons, events, or circumstances in habitual, and yet potentially malleable, ways" (Facione, 2000, p. 64). Disconnecting content knowledge from critical thinking, or focusing only on the former, reduces the opportunities for students to practice critical thinking skills or to develop critical thinking dispositions while possibly increasing teachers' workload. However, as Yuan and Liao (2023) remind us, teachers may teach critical thinking and content knowledge as two separate things instead of incorporating critical thinking throughout the curriculum. Some teachers may also believe that delivering the expected content knowledge to students may be sufficient to improve their critical thinking. In addition, during their schooling, students will meet a variety of teachers, with possibly differing visions and educational goals related to critical thinking. This may lead to inconsistent practices between teachers which then reduces the likelihood of helping students develop critical thinking skills and dispositions across disciplines throughout their schooling.

Examples of divergent educational goals for teaching critical thinking can be found in relation to two traditions: critical thinking and critical pedagogy (Burbules & Berk, 1999). In order to differentiate the historical critical thinking tradition from the concept of critical thinking itself, the latter will in the following be mentioned with its acronym CT. While both claim that developing students' CT is similar to help them think 'better', what they mean by 'better' remains subject to debate. On the one hand, the critical thinking tradition has an historical focus on logic, and students are taught to produce and evaluate arguments that are sound and logically correct (e.g., Paul, 1992). Beyond formal and informal logic, we found

more recently a focus on “scientific reasoning and avoiding bias” (Sternberg & Halpern, 2020, p. 1). On the other hand, the critical pedagogy tradition focuses on power inequalities about which the critical thinker “is empowered to seek justice, to seek emancipation” (Burbules & Berk, 1999, p. 7). In this tradition, teaching CT implies having students understand the injustice, the oppression systems, and act to change them. The school itself, as an institution, may convey and reinforce oppression and as such should itself be critically observed.

Probably due to its seemingly less controversial nature, or simply because it is more directly compatible with most curriculum, elements from the critical thinking tradition have been easier to incorporate into teaching than critical pedagogy. But how CT should be taught, and what knowledge and training teachers should have for that is still subject to debates even among the critical thinking tradition.

We first review common CT definition elements from the research done in various fields such as psychology, philosophy, educational sciences (Lai, 2011; Rear, 2019). Then, building upon a recent design-based research project in which more than 30 researchers and teachers collaborated (Jeune et al., chapter 3), we suggest a way to reconceptualize CT. Under the concept of teaching critical approaches, we elaborate a set of suggestions for the development of research-informed CT teaching. In particular, we call for teachers to be considered as potential co-producers of the research through the analysis of their own students’ mobilization of critical approaches. We then conclude with implications for teacher training and future research.

1.1 Teaching CT: balancing knowledge, skills and dispositions

Ennis (1991) broadly defined CT as “reasonable reflective thinking focused on deciding what to believe or do” (id., p. 32), and then breaks it down into lists of dispositions (such as be disposed to “seek and offer clear reasons”, ibid.) and abilities or skills (such as that of “analyze arguments”, ibid.). Most authors defining CT with an educational purpose in mind likewise divide CT into smaller components to be taught. For instance, Kurfiss (1988) distinguishes different types of knowledge necessary for CT: declarative (knowing facts and concepts in a field), procedural (knowing reasons and strategies to establish knowledge in a field), and metacognitive (knowing the pros and cons of the strategies used). In addition to knowledge (Willingham, 2008; Lai, 2011), both CT skills and dispositions are arguably important to be taught. Both can be found in highly cited definitions of CT

such as that of the American Psychological Association's report issued by Facione (1990a) or more recently by Stenberg and Halpern (2020) who state that "critical thinking is more than a set of skills; it also includes the propensity to use those skills." (p. 3), thereby showing the importance of dispositions.

In her review of the literature, Lai (2011) also lists various skills commonly described as components of CT: "analyzing arguments, claims, or evidence; making inferences using inductive or deductive reasoning; judging or evaluating; and making decisions or solving problems" (p. 10). Among the authors breaking CT into smaller elements, some put the emphasis on skills, for instance Halpern (2014) who defines CT as "the use of those cognitive skills or strategies that increase the probability of a desirable outcome" (p. 8). Other authors put the emphasis on dispositions, for instance Kuhn (2019) who states that "critical thinking is a dialogic practice people commit to and thereby become disposed to exercise, more than an individual ability or skill." (p. 148-149).

To understand the definitions of CT dispositions, the idea of a practice people commit to, or the motivation to mobilize some skills, are central. For instance, intellectual humility is a CT disposition related to a mindset or personality trait "that guides our reactions to evidence as we seek to pursue the truth and avoid error" (Ballantyne, 2023, p. 1). Such a disposition is important because, if CT is related to deciding what one ought to believe or do (Ennis, 1991), avoiding errors and taking evidence into account as best as possible are directly linked to each other.

Using the report issued by Facione (1990a) as a reference for their meta-analysis, Abrami and colleagues (2015) listed "six CT skills (including 16 'subskills') and 19 CT dispositions" (p. 3) but also report that teaching CT has been more frequently studied with a focus on skills rather than dispositions (Abrami et al., 2015). The nature of dispositions, as something both internal and context dependent, makes their evolution less visible and more complex to interpret for teachers, more difficult to evaluate, and their development may take longer, as compared to skill development (Puig et al., 2019). Therefore, it may be easier and more satisfactory for teachers to teach CT with educational aims focusing on skill development rather than dispositions. In addition, teachers may be more familiar with the development of their students' skills as many curricula now include lists of skills to be taught (Gouëdard et al., 2020; Pirone, 2023). The intrinsic difficulty to evaluate students' dispositions, associated with teachers unfamiliarity with this task, may explain the

overfocus in the scientific literature on students' CT skills development despite a wide acknowledgment of dispositions importance (Dominguez et al., 2018). The development of CT skills without dispositions may unfortunately be useless, if students end up not using those skills (Al-Ghadouni, 2021; Dominguez et al., 2018; Puig et al., 2019). In addition, it is likely that students' dispositions may lead to better CT skills development because they are more willing to practice them (e.g., Al-Ghadouni, 2021).

1.2 Epistemic, ethical and political dimensions of CT

As shown through our comparison of the critical thinking and critical pedagogy traditions, definitions of CT may more or less focus on epistemic dimensions (a critical thinker is mainly able to assess the plausibility of statements) or on moral and political dimensions (a critical thinker focuses on distinguishing outcomes based on whether they could be good or bad, fair or unfair).

One example of an epistemic-focused view of CT can be found in Pasquinelli and Richard (2023), who define CT as "the ability to evaluate the quality of available information in order to establish its susceptibility of being correct; Evaluating the quality of information equates to assessing its sources and contents (e.g., the plausibility of the contents in the light of previously acquired knowledge) as well as the evidence and arguments that support the contents" (p. 424). Pereira (2018), on the other end of that spectrum, offers a critical pedagogy inspired, political-focused view of CT which "involves implementing a process that raises learners' consciousness of social discrimination and the social relationships that underpin it" (p. 46, our translation).

The focus on the epistemic dimension may make teaching CT easier, removing some of its complexity. Indeed, Pasquinelli and Richard (2023), who narrow their CT definition to the epistemic dimension, clearly acknowledge that doing so is restrictive. Unfortunately, teaching CT restricted to its epistemic dimension often leads to counterproductive practices, such as the popular trend of 'fighting fake news' which often relies on the assumption that helping students distinguish true from false information is what matters the most. Pennycook and Rand (2021) suggest that falling for fake news implies most of the time a lack of careful reasoning and inattention, which makes us once again stress the importance of building appropriate dispositions to search for the most appropriate quality information. Altay (2022) also argues that false information can be inoffensive (e.g.,

claiming that my house is pink would be false, but there would be little CT involved in proving it, and no consequence to believing this lie), and that true information may in fact be misleading. For example, saying that it's more common for men than women to die violently is true information but it is often used to minimize violence against women. This information is misleading because it does not mention the fact that violent deaths of men are mostly caused by other men, and that the goal to reduce male violence would therefore be all the more legitimate.

In fact, judging a piece of information as 'misleading' may involve a more complex development of CT as compared with the assessment of whether claims are true or false. Being critical towards a piece of information involves taking into account the consequences of my judgment beyond my epistemic beliefs (what would it change for me and others if I judge this piece of information as true versus false?). Thinking about the personal consequences of a judgment (or other elements such as the context or the source's intention) often involve social, ethical and political dimensions of CT. This does not mean that educational interventions aiming at developing students' skills related to epistemic dimensions of CT such as evaluating a source's credibility (Geay, 2023) are irrelevant. Indeed, developing those skills along with the right dispositions seems to be consensual.

A promising venue to integrate ethical or political dimensions to educational interventions aiming at developing students' CT are those inviting to work on socio-scientific issues – "complex, characterized by uncertainties, and open-ended [issues]" (Bächtold et al., 2023, p. 765) – for which there is rarely clear-cut consensus on what a good answer is. Socio-scientific issues have indeed been studied in relation to CT (e.g., Pallarès et al., 2023), and may be related to Paul (1992)'s 'strong-sense critical thinking' (taking into account diverse groups' interests, as opposed to those of a specific individual or group which would account for 'weak-sense critical thinking').

As Pirone (2023) stated, we are still a long way from a didactisation of CT. In particular, teaching CT, linking epistemic, ethical and political dimensions about what to believe or do, thanks to the use of socio-scientific issues, is difficult. It may increase a widely shared difficulty of both research and teaching: how can we know if students' CT is improved by specific educational interventions?

1.3 Evaluating CT and teaching CT interventions

It is important to distinguish two challenges: evaluating students' CT, which depends on CT's definition, and evaluating the effect of teaching interventions aiming at developing students' CT, which depends on the first type of evaluation. To illustrate the difference with a highly simplified example, let's imagine that CT can be evaluated based on the number of 'good quality arguments' that a student produces each week, and that there would be perfect consensus on what a good quality argument is. Teachers' count of their students' arguments could in a way give a 'CT score': the higher, the better. Good teaching CT could correspond to a way to teach which would, once again in a simplified way, improve the average CT score in a school. An example for the second type of evaluation would be to see whether there is an improvement between such a score at the beginning of the year versus at the end of the year, and if a practice X leads to higher gains in students' score as compared to a practice Y.

As this already simple example shows, we could easily imagine a wide variety of ways to evaluate students' CT which would in turn influence the way to evaluate the effect of different teaching CT practices. There could be disagreements regarding CT definition and the way to evaluate students' CT, both of which are intertwined, and leading to possibly contradictory conclusions regarding students' CT. For instance, if dispositions are not included in the evaluation, we may draw conclusions about some students' skills, and decide that they are 'good critical thinkers', while they may not have the dispositions to use their CT skills and knowledge.

Researchers have tried for decades to find ways to solve the challenges previously described, with on the one hand standardized tests to be administered to students, and on the other hand, methodological recommendations to evaluate teaching interventions. In the following, we review some approaches and discuss implications.

1.3.1 Evaluating CT

Consistent and valid ways to evaluate students' skills and dispositions require that what is evaluated is consistent with the way they are defined, and CT is no exception. Without surprise, based on the fact that most CT definitions have a strong focus on skills rather than dispositions, and focus on epistemic rather than ethical and political dimensions, the ways researchers have evaluated CT focuses

more on these elements (Abrami et al., 2015; Puig et al., 2019). In addition, the validity and reliability of existing CT tests is questioned (e.g., Lai, 2011), especially when it comes to evaluating CT dispositions (Gagnon, 2011a).

Reviews from Ku (2009) and Rear (2019) indicate that the most common way to evaluate CT is through quantitative standardized testing, for instance using validated tests such as the Watson-Glaser Critical Thinking Appraisal (WGCTA; Watson & Glaser, 1980) or California Critical Thinking Skills Test (CCTST; Facione, 1990b) which use single multiple-choice response format.

Unfortunately, standardized testing on which empirical studies and meta-analyses mostly rely, using 'right or wrong' answers, may not be appropriate to deal with complex topics for which CT is of major importance. According to Ku (2009), their format cannot be appropriate to assess students' dispositions as they are intended to be discipline neutral, in general contexts, while dispositions may vary depending on the context. Rear (2019) argues further that "it is questionable whether any test that requires candidates to show reasoning can really reveal dispositions such as open-mindedness, inquisitiveness, the desire to be well informed, and a willingness to entertain other's viewpoints, which commonly feature in conceptions of critical thinking" (p. 668).

In addition, the current consensus is that only some parts of CT are generic – and can therefore be used independently of context. Using standardized tests implicitly assumes a fixed definition of CT (in order to choose the items and dimensions of the construct to be tested) as well as a genericity of what they test (in order to be used with a high level of reliability and validity in a range of educational contexts) (Lai, 2011).

This interplay between definitions and evaluation tools for CT leads us to argue that, in studies using standardized tools the definition of CT will not only be restricted for methodological reasons, but this restriction is also misleading by letting the reader believe that all dimensions of CT have been accurately measured by the tool. CT may in fact be redefined solely based on what can be measured, which may not only threaten the relevance of the construct, but also the validity of the measures: "When a measure becomes a target, it ceases to be a good measure" (Strathern, 1997, p. 308)

In addition, most tests have been designed for higher education (Rear, 2019) and many of these tests may not be suitable for secondary school students, even less

for primary school students. The fact that most tests have been designed and validated in English, also makes their use by teachers from non-English speaking countries even less likely.

It is promising but complex to evaluate CT in relation to argumentation on socio-scientific issues (Bächtold et al., 2023) or other approaches also including ethical and political dimensions of CT (e.g., Gagnon, 2011b). In order to account for the complexity of CT, qualitative assessment instruments could then be more appropriate than general, standardized tests to study students' CT (Puig et al., 2019).

1.3.2 Evaluating teaching CT interventions

The evaluation by researchers of teaching CT interventions builds upon CT tests used with students. The meta-analysis made by Abrami and colleagues (2015) has provided valuable insights such as the importance of explicit teaching of CT; promising approaches such as students' dialogue, applied problem-solving and role-playing; the importance to combine dialogue, authentic instruction and mentorship or the positive effect of mixing infusion, immersion and direct instruction.

However, important caveats should be taken before jumping to conclusions about effective teaching CT practices: as the authors themselves acknowledged, the focus on skills rather than dispositions in the studies included in their meta-analysis does not allow us to conclude about what constitutes effective teaching CT regarding the dispositions. It is possible that what works best to develop students' skills could be highly ineffective in terms of students' dispositions development, and the other way around. For instance, if a disposition for autonomous learning was sought in relation to the learning of math problem-solving skills, one could argue that a very intense explicit teaching with worked examples to math problem-solving skills could be effective in students' learning while undermining their willingness to learn autonomously. On the contrary, some forms of discovery learning are probably less effective in terms of skills acquisition related to math problem-solving, but may more easily develop students' autonomy. While this argument is purely theoretical and does not preclude the possibility of effective teaching CT practices that could improve both skills and dispositions, we argue instead that both dimensions need specific attention.

In addition, measuring the effectiveness of educational interventions means operating what Biesta calls a "complexity reduction" (2010, p. 498), which in other words means that researchers decide what is valuable and relevant (what is being measured) and exclude all other possible variables of the equation. This choice is highly political, and we argue that it is biased towards what is easy to measure, or at least easier than other variables, in this case CT skills rather than dispositions.

The global context of evidence-based education dominates the reflection about the way to evaluate teaching interventions, and advocates for the use of randomized controlled trials and quasi-experiments (Farley-Ripple et al., 2018; Mills et al., 2020). While valuable to evaluate the effectiveness of teaching practices by drawing causal relationships, it is restricted to informing what has worked and should not be used to generalize about what will work (Biesta, 2010). Here is an example of a problematic way to apply evidence-based education to the evaluation of teaching CT. First, we operate a complexity reduction by defining CT in a way that makes it measurable through standardized testing; second, we evaluate teaching CT practices based on the improvements in standardized CT test scores; third, we make claims about the most effective practices to teach CT which other teachers should reproduce.

We believe that other approaches could be more valuable to evaluate teaching CT practices. For instance, first, involving teachers in the definition of the problem and their educational goals, which is too often left vague in published research (Jeune et al., chapter 2); second, after acknowledging that the focus of a specific teaching practice may not be to develop students' CT but rather sub-components of this vast concept, co-constructing ways to evaluate them; third, evaluating the evolution of students' CT sub-components; fourth, reporting specific information about the implementation and the context (Durlak & DuPre, 2008; Lewis et al., 2016; Lima & Tual, 2022). This approach can for instance be achieved through teacher-research (Atal et al., 2022; Cochran-Smith & Lytle, 2015) or design-based implementation research (Fishman et al., 2013).

Following the work of Pallarès and colleagues (2023), if teaching CT includes the integration by students of specific norms, and that some of these norms are domain-specific, then the evaluation of teaching practices may be highly dependent on the specific teaching and learning context. For instance, while both life sciences and history classes may lead students to work on documents, the way we judge the quality of the sources may not be the same because of the different

way in which knowledge is built in those different disciplines. Involving teachers in designing ways to evaluate their practices while accounting for such differences may provide an interesting alternative to randomized controlled trials.

1.4 The transfer of CT

A long standing debate in the scientific literature on teaching CT is the question of transfer (Halpern, 1998; Stenberg & Halpern, 2020; Pasquinelli et al., 2021; van Peppen et al., 2022) which we could summarize through the question: 'given an individual who developed some CT skills in a specific context, how can we improve the likelihood that this individual also becomes capable of using these CT skills in other situations?'. This is an important question because we all want students' (CT) learning in one subject matter to be transferred to the other subject matters in school settings, and ideally to be transferred to their real-life situations beyond the classroom. The current consensus among researchers seems to be that near-transfer is possible given certain circumstances and far-transfer unlikely to happen (Lai, 2011; Willingham, 2008).

However, the concept of transfer itself is criticized, because it may be misleading (Hager & Hodkinson, 2009) as it remains highly ambiguous: how does one evaluate the 'distance' of the transfer, and does transfer refer to applying skills learned in one field at school to another field at school, or to real life situations (Lai, 2011)?

In order to remove some ambiguity regarding the concept of transfer, some researchers have more precisely defined steps for such transfer to happen in a given situation, such as the recognition of the relevance in a given context of some knowledge acquired in another context, the recall of that knowledge, and its use in the new context (van Peppen et al., 2022). Making sure that students take the habit to identify the context and compare its similarities and differences with other contexts previously encountered have been promising for learning, but not necessarily for CT skills transfer (id.).

However, in many cases the transfer in real life situations is far more complex than in school settings, and may occur for different reasons. For instance, students will certainly not encounter outside school someone who will prompt them to compare similarities and differences between situations, as a teacher would do in the classroom. In addition, the transfer concept focuses on individuals, and as such, CT transfer involves a unique individual being able to reflect about what to believe or do (Ennis, 1991) in new contexts. However, many decisions about what to do or to

believe are not taken independently by the individual: such decisions are influenced by the context and the social environment and may even be group decisions. But most conceptions of CT are not adapted to think about group CT, which is arguably more relevant for any group decision about what to do. In addition, such a switch of focus, while making irrelevant some problematic approaches to teaching and evaluating CT, could therefore open the door to new ways to teach CT. As this conception includes a more social dimension, we believe that it may be promising to reconceptualize CT with a focus on dimensions too often left aside such as the work on dispositions, ethical and political dimensions, and more qualitative evaluation methods.

2 Reconceptualizing teaching critical thinking

We have previously seen that the scientific literature on teaching CT, even after decades of work from various scientific disciplines, has not reached a consensual conceptual framework, but rather multiple views, of teaching CT. Some conceptions have been studied more than others, despite recognition of their limits (Al-Ghadouni, 2021; Lai, 2011; Puig et al., 2019). The main pitfalls discussed above relate to (1) an overemphasis on skills rather than dispositions (Abrami et al., 2015; Puig et al., 2019); (2) an overemphasis on the epistemic dimension of CT rather than its ethical and political dimensions (Burbules & Berk, 1999); (3) difficulties in evaluating students' CT and teaching practices with valid and reliable methods that take into account more complex views of CT (Abrami et al., 2015; Lai, 2011; Puig et al., 2019); and (4) a focus on the individual transfer of students' knowledge and skills (van Peppen et al., 2022).

Most ways to conceptualize CT come from research conducted exclusively among academic researchers. Because of the thoroughly documented research-practice gap (Caplan, 1979; Dwan et al., 2015; Malin & Paralkar, 2018), the involvement of teachers in research production has been reported as promising (e.g., Farley-Ripple et al., 2018; Jeune et al., chapter 3). The systematic review of reviews conducted by Jeune and colleagues (chapter 2) on the various concepts related to teachers' use of research highlighted some promising approaches such as research-practice partnerships (Sjölund et al., 2022). In these partnerships, teachers and researchers are seen as equally knowledgeable and may take different roles (Sjölund et al., 2023) in a mutually beneficial approach. Another promising approach is the teaching-research movement (Cochran-Smith & Lytle, 2015) through which teachers are empowered to produce innovative research and knowledge based on their

professional expertise. In addition, various methodological approaches to collaborative research have been developed, including design-based research (Sanchez & Monod-Ansaldi, 2015) through which teachers and researchers can co-design resources and interventions.We thus suggest reconceptualizing teaching CT by involving teachers and researchers in a collaborative endeavor so as to address known limitations in the teaching critical thinking field.

The main contribution of this work is the introduction of the concept of teaching critical approaches as an alternative to teaching critical thinking, based on a design-based research project involving teachers and researchers from various fields (Jeune et al., chapter 3). We present here the main features of this concept, and how it was operationalized in a research-brokered resource to facilitate teachers' use of research on teaching critical thinking (id.). This resource includes on the one hand promising features to facilitate teachers' use of research as described in a dedicated article (Jeune et al., chapter 3), and on the other hand a promising operationalization of the concepts introduced. We will explain how the critical approaches concept and the associated resource contribute to addressing the pitfalls described above.

2.1 Defining critical approaches

2.1.1 Dispositions at the heart of critical approaches

By focusing on critical approaches, we distance ourselves from the dominant, critical thinking tradition in many ways, one of which is to place dispositions at the heart of teaching critical approaches. This means that we encourage the explicit articulations of skills and dispositions development among students, and never restrict critical approaches to a set of skills that students could develop. In addition, while teachers' dispositions are not necessarily at the heart of teaching critical approaches, we try to encourage a reflection on the attitude one has as a teacher and the consistency between teachers' and expected students' dispositions. For instance, if intellectual humility (Ballantyne, 2023) is valued, it seems reasonable to expect that teachers would themselves show some intellectual humility to their students.

2.1.2 Epistemic, ethical and political dimensions' entanglement

Instead of restricting critical approaches to their epistemic dimension, we prefer to ground them in the complex interrelation between the epistemic, ethical and

political dimension, that is, helping students decide what to believe or do (Ennis, 1991) in complex settings. Of course, it does not mean that we cannot scaffold students' learning and that we should start with everything at once. To illustrate the difference in our approach, let's use a mathematical analogy. Teaching CT with its epistemic dimension only could be compared to teaching students geometry only. While it is arguably important, and that there is already a huge amount of things students can learn, we doubt that researchers or teachers would be satisfied with math teaching restricted to the field of geometry, and not helping them make progress in algebra or probabilities. Our view of teaching critical approaches is like math teaching, acknowledging that there is a wide range of math subfields (what we call dimensions) but still preferring to see them as a whole, and showing bridges between those dimensions. For instance, the complex information evaluation of whether an information is false but also whether it is misleading as a whole makes more sense than addressing both separately.

This is not easy. Hopefully, already existing approaches to teaching CT paved the way for such a complex way of teaching critical approaches. For instance, the work done to connect CT to the argumentative norms in the context of socio-scientific issues (Pallarès et al., 2023) illustrates both the complexity and the possibility to connect epistemic, ethical and political dimensions of critical approaches. Likewise, the work done by Gagnon (2011a) suggests constitutive elements of critical approaches which include various dimensions, and also suggests ways to analyze them from students' dialog. Two key dimensions which can be found in his work are the importance of context and consequences, when deciding what to believe or what to do. Indeed, beliefs and actions are embedded in a society, and we believe that asking ourselves about the consequences of such beliefs and actions is a major step for critical approaches to various situations. It requires knowledge in order to be able to accurately take context and possible consequences into account, but also a self-reflection on the values underlying the beliefs and actions we finally choose. Still, this social dimension can be taken a step further, when considering critical approaches as the result of a deliberation which may occur at the scale of a group.

2.1.3 From transfer to transversal mobilization, from individual to group

Most approaches to teaching CT define it in relation to individuals' knowledge, skills and dispositions (Lai, 2011). Existing tests also focus on evaluating an individual's CT (Ku, 2009, Lai, 2011, Rear, 2019). However, "critical thinking can no

longer be conceived as a matter of solitary thinking, or of autonomy of thought. Since we all depend on others for gaining and for producing knowledge and for making informed choices, critical thinking is more than ever a form of distributed cognition and a matter of creating the best conditions for reasonable trust in reliable sources" (Pasquinelli & Richard, 2023, p. 424). Trouche and colleagues (2014) have shown that, given favorable circumstances, group reasoning, mediated by argumentation, seems to be better than any individual reasoning. This raises the question of the advantages of moving from an individual view of CT to a more collective view.

The concept of transversal mobilization (Gagnon, 2008) provides us with an interesting alternative to transfer of CT. According to Gagnon, "the idea of mobilization does not necessarily lead us to see transversal skills as being mobilized by a single person within several domains or families of situations. To speak of mobilization is to emphasize the fact that, although it may be difficult for an individual to be transversally skilled, this skill could be found in a wide variety of domains insofar as it is constructed by different individuals." (2008, p. 32, our translation). Therefore the socio-constructivist view of learning applied to CT may put the emphasis on the CT of a group, instead of being limited to the individual.

In a given family of situations, different people may be critical in very different ways which could all be equally judged as being critical, taking into account the knowledge and context of the individuals. High-stakes decision-making with no time pressure could lead one individual with expert knowledge to take the time to slowly analyze the elements in order to make the best possible decision according to her goal, while another individual without expert knowledge would use that time to have multiple perspectives from other people with more expertise. Both ways could be judged as manifestations of CT independently of their results.

Using Gagnon's (2008) concept of transversal mobilization instead of transfer encompasses the plurality of ways to be critical in various contexts, possibly at the scale of a group. It gives us the opportunity to rethink one widely shared goal of teaching CT: instead of aiming for transfer of individual abilities in various contexts, we can now integrate a collective goal of a transversal mobilization of critical approaches. In a context in which many democracies are shaken by the rise of xenophobic, racist, sexist and other oppressive political movements, the need to think about a collective mobilization of critical approaches is all the more relevant. As such, teaching for transversal mobilization of critical approaches is necessary,

and there is a high need to find the best ways to teach, while welcoming teachers' and students' voices as to the definition of the goals. Then, and only then, can we open the discussion about the best and most effective practices.

2.2 Evaluating critical approaches

Our suggestion to aim for facilitating the transversal mobilization of critical approaches cuts ties with the tradition of using standardized tests trying to measure individuals' 'critical thinking' as a whole. Instead, we suggest developing a diversity of context-based ways to evaluate critical approaches, making good use of qualitative approaches (Puig et al., 2019) as well as mixed methods, focusing not only on skills but also on dispositions evaluation (Abrami et al., 2015; Ku, 2009; Kuhn, 2019; Rear, 2019), and encompassing not only the epistemic dimension but also the ethical and political ones (Burbules & Berk, 1999).

A promising approach to identify such evaluation instruments is by involving practitioners into the definition of goal- and context-dependent assessment tools. For instance, we have been guiding since 2022 a network of educators to use teaching research methods to address the various challenges related to teaching CT (Atal et al. 2022; Jeune et al., chapter 3). This approach empowers educational stakeholders, especially teachers, to produce contextual, practice-based evidence of the effect of specific aspects of teaching CT approaches. As such, it opens the door to various complementary approaches to evaluating teaching practices aiming at improving the transversal mobilization of critical approaches by students, but also of teachers' and other educational stakeholders' trainings. By design, the work of the network is appropriate to capture not only evaluation of the practices themselves but also important characteristics of their implementation.

In addition, the general framework developed by Atal et al (2022) to guide communities of educators to engage in teaching research includes activities for teachers to find, read and use academic research, or to get in touch with specific researchers. Such activities can contribute to providing teachers with the evaluation tools they need, and to contribute to their learning about research methods – what researchers call process use of research (e.g., Doucet, 2019). Through this learning process, we believe our network dedicated to teaching critical approaches could increasingly provide teachers the skills and support to rigorously evaluate by themselves whether their practices help achieve the goals they have set, and as such, whether it is beneficial for students. We do not claim to

end the debate about the way CT should be defined or evaluated, instead, by inviting all teachers, researchers and other educational stakeholders to join the network, the concept of critical approaches may simply provide a fertile ground to advance both research and teaching together.

2.3 Four axes of teaching critical approaches for transversal mobilization

The resource on teaching critical thinking created as part of our design-based research project and its interaction with the above-mentioned teacher-research network dedicated to teaching critical approaches has four major axes. In the following, we will describe each axis and discuss why we believe they are of major importance.

The four axes are the relationship to knowledge; metacognition and reflexivity; argumentation; and information evaluation. Each axis will be briefly described below, while more information about the process or the structure can be found in another study (Jeune et al., chapter 3).

The conclusion of the resource as well as the global visual synthesis eventually described how the different axes interact with each other, and how teacher collaboration is necessary to achieve the best possible results in helping students' transversal mobilization of critical approaches.

2.3.1 Relationship to knowledge

The chapter dedicated to our relationship to knowledge introduces to the problems associated with the use of the hierarchy of evidence and suggests instead to focus on teaching elements related to epistemic beliefs or the Nature of Science. We largely draw upon the work of Gagnon (2011b) in relation to the nature of knowledge and the act of knowing, but also upon Hasni and colleagues (2018) in relation to scientific inquiry in schools. The work of Bächtold and colleagues (2021) helps us connect scientific inquiry with the concept of Nature of Science, which we adapted, talking instead of nature of sciences, to open it to a plurality of sciences. Our recommendations focus on the questioning, on the teaching attitude, and the need to collaborate in a transdisciplinary way for students to benefit as much as possible from diverse types of knowledge sources.

In addition, we refer to Kuhn and colleagues' (2000) model of epistemic beliefs, with the relationship between absolutist, multiplist and evaluatist perspectives to

critical approaches. We draw upon De Checchi (2021) to move away from these authors' developmental perspective and suggest instead considering epistemic beliefs as postures which depend on the context and may evolve in a non-linear way. Then, coming back to the work of Gagnon (2020), we illustrate the expected evolution of representations of the nature of knowledge and the act of knowing. Finally, we suggest ways to diagnose students' epistemic beliefs and possible actions to help students build more elaborated relationships to knowledge.

2.3.2 Metacognition and reflexivity

The chapter dedicated to metacognition and reflexivity introduces to the problems associated with teaching cognitive biases and suggests instead to focus on metacognitive strategies and dispositions related. After defining metacognition in relation to the usual intuition of thoughts about one's own thoughts, we build upon the work of Allix and colleagues (2023) to describe metacognition as composed of knowledge, experiences and skills which contribute to either monitoring or controlling of one's own cognitive processes. We also build upon the work from Kuhn (2022) about the links between metacognition and critical approaches, for instance with the importance of thinking of metacognition mainly as a disposition; that is, stressing that the effortful process of metacognition should first and foremost be perceived as relevant and meaningful for students, more than simply developing the associated metacognitive skills. She stresses the importance of inhibiting and filtering our ineffective strategies more than simply being able to know which strategies are adapted. We share her recommendations to scaffold the development of metacognitive strategies in a dialogical context and draw upon Lai (2011b) about effective strategies to develop students' metacognition. For instance, we stress the need for explicit teaching about metacognition, including the explicitation of the benefits of such learning, and the relevance of dialogic, cooperative learning environments to motivate students. As metacognition is mostly internal, we recommend ways to observe and evaluate its manifestations, but we also stress the importance to go beyond metacognition and also use the reflexivity concept, so as to include the socio-economic, political and relational dimensions (Barbier & Seurrat, 2023). We put the emphasis on one important disposition: intellectual humility. Building upon the work from Ballantyne (2023), we show the links between metacognition and intellectual humility as a desirable way forward to teaching critical approaches.

2.3.3 Argumentation

The chapter dedicated to argumentation introduces to the problems associated with teaching fallacies and suggest instead to focus on what makes good argumentation, which is central in the work around CT of many authors (Gagnon & Michaud, 2021; Kuhn, 2019 ; Nussbaum, 2021 ; Rapanta & Felton, 2022). We use the work done by Pallarès (2019) as a structure to explain argumentation, describing arguments as made of both contents and functions, all of which happens based on a set of argumentative norms. We use her categories of contents, functions and norms as the starting point for argumentation on socio-scientific issues, which we already mentioned as especially important for teaching critical approaches. We then introduce three types of argumentative practices inspired by research. First, we introduce the work of Nussbaum (2021) on critical integrative argumentation, aiming at building complexity in students' thinking through a well designed argumentation context, integrating both arguments and counter-arguments, all of which assessed with a list of critical questions. Then, we introduce Kuhn's (2019) dialogic approach to argumentation, using both oral and writing contexts in which pairs of students work together. Finally, we introduce philosophy with children and teenagers as a whole-class argumentative context, based on the work of Gagnon and Michaud (2021) or Tozzi (2021), inspired by the seminal work from Lipman and Sharp (1978). While today's practices evolved in many directions, we suggest that the work from Sasseville and Gagnon (2012) on thinking abilities can help teach and evaluate relevant elements which can be observed during philosophical dialogue. Finally, we stress the importance of taking into account emotions as part of argumentation, and give suggestions in this regard, building upon the work done by Polo and colleagues (2016).

2.3.4 Information evaluation

The chapter dedicated to information evaluation introduces the limitations of the 'fighting Fake news' view, following Altay (2022). We describe a cognitive view of the search of information from Boubée and Tricot (2010) and the central role of the information-seeker's uncertainty. We describe the limitations of the cognitive view and build upon the work from Cordier (2019) or Sahut (2017) in the field of communication studies and information sciences. They suggest taking into account students' actual informational practices and their experience from which to build dispositions related to the motivation to search new information and to evaluate its credibility. Once again, we stress the importance of emotions in such a process

(Boubée & Tricot, 2010; Cordier, 2019). We suggest that teachers could switch towards an attitude more horizontal and questioning with their students to facilitate students' positive emotions associated with information evaluation, with teachers as co-inquirers instead of 'knowers'. We have used the work from Geay (2023) as the basis for the evaluation of the credibility of the information, including the evaluation of the sources' competence and the confidence they deserve, themselves broken down into subcomponents. We also use the work from Bosler (2023) to suggest where teachers may find other pedagogical tools and approaches. Finally, we give recommendations based on Brante and Strømsø (2018) about pedagogical interventions to work on information sources, and we suggest based on different authors that links between the previous chapters and information evaluation could be fruitful. We conclude this section with recommendations from Jehel and Saemmer (2017), Desfriches Doria (2018), Sahut (2015, 2017) and Neveu (2019) about the choice of angle and themes to work information evaluation with students. One overarching recommendation regards the importance to think about the consequences of trusting information, and not just whether it is true, as outlined previously in the current article.

The visual syntheses of each chapter can be found in appendix 12, and give a better idea of the contents of each chapter which we only briefly summarized.

3 Conclusion

Throughout this article, we have portrayed the current limitations faced by researchers studying teaching CT. We have explained that the current overemphasis on skills rather than dispositions and on epistemic elements rather than integrating ethical and political dimensions about what to believe or do is limited and likely to lead to problematic teaching practices. We have also described the difficulties regarding the evaluation of both students' CT and the effects of teaching CT practices. Finally, we have reached the conclusion that a vision focusing on the transfer of CT was subject to criticism.

In order to overcome those challenges, we have suggested reconceptualizing CT under the concept of critical approaches, based on a design-based research project involving many teachers and researchers from various fields. Our concept of critical approaches and its teaching stress the high importance of dispositions and the integration of ethical and political dimensions. It also moves beyond the dominant view of CT as an individual's set of skills, and opens the door to considering critical approaches as produced by a group, which would greatly change the way we

evaluate critical approaches. To the best of our knowledge, this has not been conceptualized in this regard, and we believe that both researchers and teachers would benefit from this change of perspective. We have also suggested the importance of taking into account the consequences of such actions and beliefs, and we put forward the idea to think about transversal mobilization of critical approaches instead of transfer of CT. As for the evaluation, we suggest the use of teaching research (Atal et al., 2022; Cochran-Smith & Lytle, 2015) in collaboration with researchers to co-create new qualitative and mixed-methods evaluation tools.

While this paper does not aim to give empirical evidence of the effect of using the term teaching critical approaches instead of teaching critical thinking, it gives the theoretical foundations for future research. Current work by the research team aims at filling the empirical gap by using the research-brokered resource described above including our conceptual framework as part of teacher training sessions. Such a research may suggest ways to improve the framework while providing evidence for some of its benefits, especially considering teachers' process, instrumental and conceptual use of research.

However, as many previous studies related to teachers' use of research, evidence, data or knowledge have shown, the external systemic and organizational contexts play a major role in teachers' actual practices (Jeune et al., chapter 2; Rickinson et al., 2022). Research increasingly suggests that institutional support is needed to facilitate teachers' use of research and that a top-down approach is doomed to failure. Without institutional support, we believe that despite its promising features, it is likely that only very motivated teachers will be able to make use of such a resource. We hope that our contribution to creating a resource with deep conceptual research-inspired roots as well as teacher-friendly contents can facilitate long-term changes across educational systems.

Integrative conclusion

In the five articles comprising this dissertation, we have explored various theoretical and methodological frameworks related to teachers' use of research. Our first article built upon the most cited framework, suggested by Weiss and Bucuvalas' (1980), which distinguishes between instrumental, conceptual, and symbolic use of research by teachers. This model was later expanded to include imposed use and process use (Doucet, 2019), but our first study primarily focused on instrumental and conceptual uses of research. Our second article also referenced these frameworks but delved deeper into teachers' use of research by including related terms and frameworks. We grouped research, evidence, data and knowledge in a single acronym, REDaK, to explore a wide range of concepts related to teachers' use of REDaK. Our systematic review of 32 reviews resulted in a vast amount of concepts found, which we grouped in the following categories: data-based decision-making; research-practice partnerships; implementation of evidence-based practices; use of research; brokerage; research-to-practice gap; sensemaking; research-teaching nexus; translational research; research dissemination.

In addition to these terms, we frequently referenced Farley-Ripple and colleagues' (2018) conceptual framework linking teachers' use of research with researchers' production of research, as well as their entanglement. This model acknowledged the importance of linking teachers' use and production of research, which various collaborative research frameworks can support. For instance, Sjölund and colleagues' (2022) review suggested different types of research-practice partnerships which could contribute to linking teachers' use and production of research in several ways. Research methodologies such as inquiry methodologies (e.g., teacher inquiry), design methodologies (e.g., design-based research) or improvement science methodologies (e.g., networked improvement communities) all showed potential for instrumental, conceptual and process use of research to various extents (*id.*). As a concluding remark of our second article, we propose a specific teacher-research 'meta' framework (Atal et al., 2022) noting that it is flexible and may work well as part of an inquiry, design or improvement science research-practice partnership.

Building upon the fields of brokerage (Rechsteiner et al., 2023; Rycroft-Smith, 2022) and research-practice partnerships (Coburn et al., 2013; Penuel et al., 2020; Sjölund et al., 2022, 2023; Vetter et al., 2022; Wei & Huang, 2022), we aimed to

connect the design-based research methodology (Anderson & Shattuck, 2012; Sanchez & Monod-Ansaldi, 2015) with the creation of research-brokered (Rycroft-Smith, 2022) resources – resources inspired by research and practice, designed to better facilitate teachers' use of research. Findings from Cooper (2014) indicate that such a resource may not be enough to facilitate teachers' use of research, and that networks are crucial. Therefore, we dedicated most of the work done throughout this PhD to a design-based research project, enhanced by a teacher-research network following Atal and colleagues' (2022) framework.

Much of the literature on the research-practice gap (Crain-Dorough & Elder, 2021; Sjölund et al., 2023; Taylor et al., 2023) has used a narrative of 'two communities' to describe teachers on one side and researchers on the other (e.g., Neal et al., 2019). Our work questioned this view, both theoretically, by reviewing the literature, some of which is critical of this frame (Knight, 2024; Neal et al., 2019; Newman et al., 2016), but also empirically. Our first article studied the influence of the role (teacher, researcher, trainer or decision-maker) of respondents to our survey about which factors could affect teachers' use of research. Our results show many similarities between teachers' and researchers' responses, but also highlight differences with other educational stakeholders. Additionally, our fourth article compared teachers' and researchers' motivations to engage in collaborative research, both in general and at specific steps of our design-based research. This provided interesting insights into the limited differences between both groups of respondents, adding nuance to the 'two-communities' framework. Since we found some differences in motivations to participate in different steps of collaborative research, we suggest that future research should look beyond the 'two communities' to understand when and why teachers and researchers differ regarding teachers' use or production of research. Additionally, as emphasized in our second article, the importance of other educational stakeholders, such as those included in our first study (trainers and decision-makers), is significant. But individuals have limited power. Cultures, infrastructures and systems largely drive teachers' possibilities to use and produce research in the long run.

Another significant contribution of this dissertation is the articulation of teachers' use of research on the specific topic of teaching critical thinking, which we reconceptualized as teaching critical approaches. Many studies have either used teachers' use of research as a means to achieve a goal related to a specific teaching problem, or have focused on teachers' use of research as the main subject while not thoroughly studying the teaching problem itself. Our fourth article suggests that

teachers and researchers may have varying motivations for different steps of a collaborative research project. Similarly, not all teachers and researchers are likely motivated by the same teaching problems. Likewise, probably not all teachers and researchers would be motivated by the same teaching problems. Moreover, the existing research to be used – or the ways in which we can produce new research – depend on the teaching problem at hand.

With this in mind, studying both teachers' use of research and teaching critical thinking was both a methodological challenge and a necessary step to study teachers' use and production of research *in context*. In the third and fifth articles, we argue for the widely acknowledged importance of teaching critical thinking (Dominguez et al., 2018; UNESCO, 2016; Vincent-Lancrin et al., 2020) even though its meaning is still debated (our contribution to this debate is central in our fifth article). Our work provides a convincing example of how design-based research, inspired by literature on research-practice partnerships and brokerage, can be integrated with a teacher-research network. Their combination provided a promising resource to facilitate teachers' use of research on teaching critical thinking, while the network served as a privileged context for their production of research on this topic. Acknowledging the importance of the structural and systemic – highly political – dimensions that made this work possible, we hope our approach can help other researchers better collaborate with teachers, fostering a shared vision of teachers' use and production of research as interconnected. For both researchers and teachers, this would require a significant cultural shift in the current evidence-based context: as researchers, we must acknowledge teachers' expertise, show genuine interest in the specific contexts in which they work, and build mutual trust.

Previously, we provided an overview of this dissertation's contributions to the field of teachers' use of research, its integration with previous literature, and its operationalization through the concrete example of teaching critical thinking. Our dissertation also contributes to the field of teaching critical thinking, mainly through the work reported in the third and fifth articles. The former provides more insights about the structure, while the latter focuses on the contents and the reconceptualization of teaching critical thinking as teaching critical approaches.

The theoretical argument for the conceptual shift from critical thinking to critical approaches arises from the limitations acknowledged by several researchers regarding teaching critical thinking. We discuss these limitations and the

preference for teaching critical approaches in our fifth article. For instance, we report an overemphasis on critical thinking skills rather than dispositions (Abrami et al., 2015; Al-Ghadouni, 2021; Dominguez et al., 2018; Puig et al., 2019); on its epistemic dimension rather than the ethical and political ones (Abrami et al., 2015; Bächtold et al., 2023; Pasquinelli & Richard, 2023; Puig et al., 2019); on evaluating students' critical thinking and teaching practices with standardized tests (Ku, 2009; Rear, 2019) the validity of which is questionable (Gagnon, 2011a; Lai, 2011); and on the transfer as the final aim (Halpern, 1998; Stenberg & Halpern, 2020; Pasquinelli et al., 2021; van Peppen et al., 2022). Based on these features, we argue for the relevance of teaching critical approaches as a way to shift focus from the individual and, with it, from transfer and standardized measurements of critical thinking. As we can observe a decision made by a group, their decision about what to do (Ennis, 1991) can illustrate a critical approach. We argue that critical approaches emphasize the complex integration of skills and dispositions on one hand, and epistemic, ethical, and political dimensions on the other. Deciding what to believe or what to do always depends on a context, and it has consequences that should be considered for an approach to be critical.

Beyond the theoretical argument, an important feature of our concept of critical approaches is its development for operationalization through a research-brokered resource, co-created by diverse teachers and researchers throughout our design-based research. This focus on operationalization was directly related to our concern for teachers' use of research, particularly its adaptability for a target audience of teachers and the inclusion of elements facilitating the conceptual and instrumental use of research. These three elements correspond to three factors we identified in our first article on factors influencing teachers' use of research according to different educational stakeholders. Our first article concluded that each of these factors were judged as playing a significant role in teachers' use of research. A fourth factor was the collaboration between teachers and researchers on teachers' use of research, which our design-based research specifically contributed to. A fifth factor was the involvement of teachers in the production of research, which was also the focus of our teacher-research network. The last factor, institutional support, was unfortunately beyond our reach.

In other words, our global work first identified six factors influencing teachers' use of research to varying degrees, and throughout this dissertation, we have reported on how we operationally implemented them to facilitate teachers' use of research on teaching critical thinking. While empirical work is still needed to evaluate the

extent to which the combination of teachers' use of the resource and their participation in the network actually facilitates teachers' use of research on teaching critical thinking, we have already made a strong theoretical argument. We not only built upon the factors identified in our first study, consistent with previous research (e.g., Dagenais et al., 2012), but also based our entire methodology on promising frameworks for facilitating teachers' use of research, as identified in our second study. Finally, our third study reported on the overall process and successful relationship between resource creation and the teacher-research network; our fourth study contrasted teachers' and researchers' motivations to engage in collaborative research; and our fifth study developed the rationale for teaching critical approaches, which is central to the newly designed resource.

We have used and mastered a wide range of approaches to study teachers' use of research on teaching critical thinking, including factorial survey experiments (first article), systematic reviews (second article), content analysis (third article), multilevel analyses (fourth article), and theoretical argumentation (fifth article). We borrowed from various epistemologies, ranging from more post-positivist, quantitative, *evidence-based* approaches to more socio-constructivist, qualitative, critical approaches. Politically, our work is heavily influenced by critical theory and social justice oriented perspectives, which has shaped my approach to collaborating with researchers and teachers alike, working against power imbalances and striving to ensure teachers' knowledge is rightfully recognized.

All the work done as part of this PhD raises more questions than it answers. One promising direction for future research is gaining a better understanding of teachers' and researchers' (and other educational stakeholders') views and past experiences with collaborative research in specific countries or contexts. As our work suggests, specific collaborative projects, depending on their methodology and their topic, may influence teachers' and researchers' motivations to engage. Documenting a variety of views could pave the way for designing more relevant collaborative research, such as research-practice partnerships, in which power inequalities could be better addressed by identifying problems before starting collaborations.

Another promising, more theoretical research avenue would be to further link critical approaches to teachers' use of research. One of the main focuses of teaching critical approaches, as we conceptualize it, is the relationship to knowledge. We could then use critical approaches to frame teachers' use of

research, arguing that teachers' conceptual and process use of research, in particular, may shape their relationships to knowledge. Similarly, leveraging the scientific literature in the fields of metacognition and reflexivity (the second focus of teaching critical approaches) could provide insights into ways to facilitate teachers' use of research by developing their metacognition and reflexivity. Argumentation (the third focus of teaching critical approaches) is also central to teachers' production of research, and argument evaluation could likely be linked to teachers' use of research. Finally, information evaluation (the fourth focus of teaching critical approaches), could also be linked to teachers' use of research, as they evaluate the credibility of the information found in research. In other words, would it make sense to reconceptualize teachers' use and production of research in relation to teachers' critical thinking? (Huang & Sang, 2023; Osana & Seymour, 2004; Robert & Garnier, 2015; Wang & Jia, 2023; Yuan & Liao, 2023).

Additionally, our systematic review of reviews (article 2) provides a comprehensive cartography of concepts and terms related to teachers' use of research. A good way to build upon this would be to conduct large-scale lexicometric analyses of the vast scientific literature in the field of teachers' use of REDaK. This could contribute to improving the conceptualization suggested as part of that article, with a limitation being that it focused on a limited number of reviews, and may not be fully representative of the field.

Also building upon specific studies included in this dissertation, we believe that our design-based research project could be improved, and reiterated. The new resource and network could be the basis of another review, followed by meetings to sort changes. We would probably do it differently as we've learnt from our experience, and as the starting point (the new resource) is probably more comprehensive and adapted for teachers than the initial resource. However, one important, ongoing limitation which we could address, is the inclusion of more primary school teachers, and the scaffolding of different elements of teaching critical approaches in a consistent way across all school levels, subject matters, and curricula. To teachers' question 'What should I start with?' in relation to teaching critical thinking, the honest answer should in most cases be: 'I don't know'. Continuing this research project with new researchers from didactics and various teachers, focusing together on specific contents and age groups could be a way to contribute to the didactisation of critical thinking (Pirone, 2023).

But all of these ideas are… ideas. Unless we, researchers and teachers, have dedicated funding and institutional support for such demanding collaborations, most of this dissertation will remain useless. Our work is simply another brick in the wall.

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Appendix 1 - Definitions of each REDaK

	Definitions
Research	**Definitions found in 5 articles** (Dagenais et al., 2012; Pereira et Fang, 2022; Schaik et al., 2018; Sjölund et al., 2022; Wei & Huang, 2022) « We make a distinction between general research-based information, which is the scientific evidence found in the literature (in scientific publications, systematic reviews, etc) and local research-based information, which is produced locally and intended for local use. The latter is the case, for example, of the evaluation of a single school program or of participatory action research. In these types of research, the goal is to provide feedback and the utilisation of results focuses on a particular program. When the results of these research activities are disseminated or used in other contexts, they then become general research-based information » (Dagenais et al., 2012, p. 286) « Contrary to teacher knowledge, academic research knowledge is seen as objective, codified by research, expressed in formalised ways, generalised, impersonal, and generated in order to develop theory (Cain, 2016; Wieser, 2016). [...] knowledge generated by researchers from the academic community » (Schaik et al., 2018, p. 51) « In this paper, "research" is defined as theory oriented knowledge-production activity, which brings out ideas, interventions, and influences by researchers from universities or other research-oriented institutions involved in [lesson and learning studies]. » (Wei & Huang, 2022, p. 139) « teacher research as a systematic and rigorous process designed to explore and extend teacher knowledge [...] Another important feature of teacher research is the inquiry stance (Cochran-Smith & Lytle, 2009). This is where research is regarded as a worldview, a critical habit of mind, a dynamic and fluid way of knowing and being in the world of educational practice that carries across professional careers and educational settings [...] the inquiry stance is a disposition that is active; meditative; focused on existence, being and reality; concerned with the theory of knowledge in terms of methods, validity, and scope, investigative of both micro and macro issues, as well as both the personal and political » (Pereira et Fang, 2022, p. 162) « Four distinct categories based on the purposes of research theories are described. First, descriptive theories aim to describe reality as it is [...] Secondly, explanatory theories go further, aiming to explain why or how certain phenomena exist. […] Thirdly, predictive theories utilise descriptions of how and why things work to predict possible effects under certain

	circumstances. [...] Lastly, prescriptive or normative theories recommend promising strategies based on cause-effect relationships. » (Sjölund et al., 2022, p. 4)
Evidence	**Definition found in 1 article** (Piety, 2019) « Evidence can be inclusive of data collected from practice as discussed in this chapter but can also include inferences based on research that certain kinds of approaches are sound and “evidence based.” » (Piety, 2019, p. 404)

Data	**Definitions found in 7 articles** (Cooper et al., 2020; Datnow & Hubbard, 2015; Goffin et al., 2022; Harshman & Yezierski, 2017; Marsh, 2012; Piety, 2019; Ruhter & Karvonen, 2024) « The nature of the data that are included in studies across these literatures has evolved [...] Data-driven decision-making (DDDM) : • High-stakes tests scores or high-stakes progress proxies, for example, formative/interim assessments • Fine-grained reading measures • Demographics • Examples of student work • Goals • Data visualizations EDM [...] Educational data mining (EDM) : • Trace data from cognitive tutors • Online course participation data • Web server logs • Multimodal data (e.g., speech, gesture) • Game and simulation data • Administrative data sets [...] Learning analytics (LA) : • Log data from MOOCs and learning management systems • Social network data • Personal experience telemetry • Complex visualizations • Game and simulation data [...] » (Piety, 2019, p. 409-410) « data that educators are drawing on are wide ranging as well, including data on student achievement, student attendance and behavior, course enrollment patterns, postsecondary success rates, and school climate, among others » (Datnow & Hubbard, 2015, p. 2) « the definition of data is broad, encompassing not only student test results but also other outcome (dropout and graduation rates), input (student demographic information), process (data on quality of instruction or program implementation), and perception (survey results or opinions from teachers, students, and parents) data. Unlike “evidence” or “information,” the focus here is on raw data that must be organized, filtered, and analyzed to become information, and then combined with stakeholder understanding and expertise to become actionable knowledge » (Marsh, 2012, p. 3) « data (systems) as sensemaking resources, that is, as triggers and tools for sensemaking. These papers discuss (interpretive) processes and responses associated with different types of data and representational qualities of data, and the ‘interpretive flexibility’ of data use technology. » (Goffin et al., 2022, p. 14) « Data such as state assessment data can be regarded as a manifestation of accountability policy (Jennings, 2012). From an institutional perspective, data such as standardised test scores ‘embody particular representations of what it means to learn and teach’ (Spillane, 2012, p. 131). They are instances of commensuration (fitting attributes into one common metric). As such, they simplify performance into something that can be measured and thereby draw attention to specific aspects of learning and instruction (Sellar, 2015; Spillane, 2012). As artefacts, standardised test scores are symbolic representations of achievement, but it is important to note

	they are also the result of a conscious transformation (Knight & Yorke, 2008; Sellar, 2015). And, like sensemaking in itself, any form of commensuration or 'datafication' is creative and adds something to the world (Sellar, 2015). » (Goffin et al., 2022, p. 24) « different types of data have different 'modal affordances' according to the conventions, beliefs and strategies that interpretive communities establish around them. Data are material-semiotic artifacts: their concrete representational properties—for example, whether they are narrative or numeric—carry meaning and value because people have grown to interpret them and act upon them in specific ways (Fjørtoft & Lai, 2021). Narrative data tend to be associated with evolving storylines and informal, micro-level decision-making, for instance. Numeric data such as test scores and other statistical, psychometric data, on the other hand, have an aura of certainty and objectivity even though recipients sometimes struggle with interpreting them appropriately (Fjørtoft & Lai, 2021). Awareness of these modal affordances—the way specific types of data become associated with specific beliefs and practices—offers a way of looking at why certain data are overemphasised or accepted as valuable and valid (Mandinach & Schildkamp, 2021). It also enlightens sensemaking challenges and opportunities, for instance in terms of data triangulation. » (Goffin et al., 2022, p. 24-25) « formative, summative, diagnostic, proximal, or distal assessments. Stated otherwise, we believe that all assessments produce data » (Harshman & Yezierski, 2017, p. 98) « data can include both school- and district-level information (e.g. instructional data, student achievement data, policy data) as well as research evidence. » (Cooper et al., 2020, p. 10) « Data sources [...] can include formative assessments as well as curriculum-based measures (CBMs), or collecting data on discrete skills » (Ruhter & Karvonen, 2024, p. 45)
Knowledge	**Definition found in 1 article** (Rycroft-Smith, 2022) « the distinction has been drawn between explicit or codified knowledge—that which is transmittable in formal, systematic language—and tacit knowledge, which is suggested as having a more personal quality, rooted in action, which makes it hard to formalise and communicate » (Rycroft-Smith, 2022, p. 24)

Appendix 2 - Quality features of REDaK

Quality REDaK features	Articles citing quality features of REDaK
Relevant or worthwhile	« The simplest issues are relevance (e.g., how related research is from their practice) and utility (e.g., what value research has in practice). » (Wang et al., 2023, p. 12) « applicability and relevance of research knowledge » (Schaik et al., 2018, p. 57) « whether teachers are more likely to find quantitative or qualitative research more relevant and convincing » (Cain, 2016, p. 621) « Research is seen as most worthwhile when it is done by teachers themselves, using action-research cycles » (Cain, 2016, p. 618) « The oft-cited theory-practice mismatch stems from the view that theory remains separate and irrelevant for the particularity of practice. » (Pereira et Fang, 2022, p. 159) « relevant to the local context » (Sjölund et al., 2022, p. 17) « The value, relevance, and timeliness of research information » (Hemsley-Brown et Sharp, 2003, p. 460) « well-established knowledge with practical relevance » (Dagenais et al., 2012, p. 285)
Timely or up-to-date or with longevity	« providing reports that are not just readable but also timely. » (Penuel et al., 2020, p. 15) « up-to-date information on student performance » (Penuel et al., 2020, p. 15) « assessment data used for DBDM must be [...] available in time for use (Brown et al., 2014), and available throughout the whole school year » (Hoogland et al., 2016, p. 383) « made available at appropriate times » (Dagenais et al., 2012, p. 303) « up-to-date evidence » (Jones et al., 2022, p. 2) « longevity and efficacy of educational research » (Wei & Huang, 2022, p. 148) « research that is both timely and useful » (Sjölund et al., 2023, p. 1492) « The value, relevance, and timeliness of research information » (Hemsley-Brown et Sharp, 2003, p. 460)

Usable, practical, provide suggestions or applicable	« making research usable, accessible and trustworthy » (Grima-Farrell et al., 2011, p. 126) « should provide suggestions for teachers on what they can change to enhance student learning in their classroom. » (Hoogland et al., 2016, p. 383) « applicability and relevance of research knowledge » (Schaik et al., 2018, p. 57) « practical usability of advanced knowledge » (Dagenais et al., 2012, p. 285) « public, useful and practically beneficial » (Dagenais et al., 2012, p. 285) « raw data (test scores or event data from digital environments) are collected and subsequently go through a series of state changes to become more usable and connected to organizational decisions » (Piety, 2019, p. 410) « look for research which can be of practical benefit » (Cain, 2016, p. 625)
Credible or convincing or consistent or trustworthy or verifiable or reliable	« assessment data used for DBDM must be high quality, that is, reliable and valid. » (Hoogland et al., 2016, p. 383) « whether teachers are more likely to find quantitative or qualitative research more relevant and convincing » (Cain, 2016, p. 621) « making research usable, accessible and trustworthy » (Grima-Farrell et al., 2011, p. 126) « the need for consistent research findings » (Grima-Farrell et al., 2011, p. 130) « This cycle of research results in a continual accumulation of instructional strategies that are public, shareable, and verifiable, finding their legitimacy in the “local proof” of the research process » (Phelps, 2019, p. 16) « Research characteristics identify the quality of the knowledge product, which is determined in part by the method used to produce it and its scientific properties of validity and reliability. » (Dagenais et al., 2012, p. 296-299) « properties of the data (e.g., reliability, validity) » (Marsh, 2012, p. 38)

User friendly, readable, formated, rescaled explicit, of appropriate design, easy to interpret or formalised	« These feedback reports should be comprehensive, easy to interpret and user-friendly » (Hoogland et al., 2016, p. 383) « providing reports that are not just readable but also timely. » (Penuel et al., 2020, p. 15) « Research knowledge can be transformed into brokered knowledge in several ways: • it can be made accessible by changing the language it is encoded in • it can be made into a different format, medium or modality • it can be distilled, synthesised or summarised (what I consider rescaling » (Rycroft-Smith, 2022, p. 11) « the distinction has been drawn between explicit or codified knowledge—that which is transmittable in formal, systematic language—and tacit knowledge, which is suggested as having a more personal quality, rooted in action, which makes it hard to formalise and communicate » (Rycroft-Smith, 2022, p. 24) « raw data that were cleaned, summarized, and put into an analytic format. » (Piety, 2019, p. 410) « evidence from empirical studies that have the most appropriate design » (Hemsley-Brown et Sharp, 2003, p. 450) « open, well-designed resources » (Jones et al., 2022, p. 11)
Valid or generalizable	« Research characteristics identify the quality of the knowledge product, which is determined in part by the method used to produce it and its scientific properties of validity and reliability. » (Dagenais et al., 2012, p. 296-299) « concerned with the theory of knowledge in terms of methods, validity, and scope » (Pereira et Fang, 2022, p. 162) « the way specific types of data become associated with specific beliefs and practices—offers a way of looking at why certain data are overemphasised or accepted as valuable and valid (Mandinach & Schildkamp, 2021) » (Goffin et al., 2022, p. 24-25) « assessment data used for DBDM must be high quality, that is, reliable and valid » (Hoogland et al., 2016, p. 383) « properties of the data (e.g., reliability, validity) » (Marsh, 2012, p. 38) « academic research knowledge is seen as objective, codified by research, expressed in formalised ways, generalised, impersonal, and generated in order to develop theory » (Schaik et al., 2018, p. 51)

Accessible	« making research usable, accessible and trustworthy » (Grima-Farrell et al., 2011, p. 126) « accessibility of research knowledge » (Schaik et al., 2018, p. 57) « Research knowledge can be transformed into brokered knowledge in several ways: • it can be made accessible by changing the language it is encoded in » (Rycroft-Smith, 2022, p. 11) « Qualitative assessment data (from free response, essay, fill-in-the-blank, etc.) is also widely accessible to teachers » (Harshman et Yezierski, 2017, p. 103) « Systems that make data accessible and organize data can support DBDM » (Hoogland et al., 2016, p. 384)
Useful	« The simplest issues are relevance (e.g., how related research is from their practice) and utility (e.g., what value research has in practice). » (Wang et al., 2023, p. 12) « Assessment systems used for DBDM also need to provide information that is useful and meets user needs » (Hoogland et al., 2016, p. 383) « research that is both timely and useful » (Sjölund et al., 2023, p. 1492) « public, useful and practically beneficial » (Dagenais et al., 2012, p. 285)
Objective or systematic or impersonal	« make educational research more rigorous, objective, and scientific » (Basckin et al., 2021, p. 2) « academic research knowledge is seen as objective, codified by research, expressed in formalised ways, generalised, impersonal, and generated in order to develop theory » (Schaik et al., 2018, p. 51) « Numeric data such as test scores and other statistical, psychometric data, on the other hand, have an aura of certainty and objectivity » (Goffin et al., 2022, p. 24-25) « informal data such as classroom observations, over formal (i.e., systematically collected) data such as test scores and information about school composition, to research findings and big data » (Goffin et al., 2022, p. 2) « Data used for DBDM are systematically collected through such means as standardized tests, formal tests, and structured classroom observations » (Hoogland et al., 2016, p. 378)

Public, open or shareable	« public, useful and practically beneficial » (Dagenais et al., 2012, p. 285) « This cycle of research results in a continual accumulation of instructional strategies that are public, shareable, and verifiable, finding their legitimacy in the “local proof” of the research process » (Phelps, 2019, p. 16) « open, well-designed resources to support them in becoming active in research » (Jones et al., 2022, p. 11)
Scientific, quantitative, rigorous	« make educational research more rigorous, objective, and scientific » (Basckin et al., 2021, p. 2) « evidence about what works, which itself is based in quantitative data about educational outputs. » (Cain, 2016, p. 618) « conducting rigorous research that simultaneously makes an impact and informs practice » (Sjölund et al. 2023, p. 1491)
Practice-informed	« practice-informed research » (Rycroft-Smith, 2022, p. 2)
Comprehensive	« comprehensive evidence base » (Hoogland et al., 2016, p. 382)

Appendix 3 - Definitions of quality use of REDaK

	List of articles providing an explicit definition of the use of REDaK

Data use, data-based decision-making, data-driven inquiry, data-driven decision-making 10 articles	« Actionable data use is one umbrella term for several research traditions using data collected from educational practices to inform, alter, and guide those same practices. » (Piety, 2019, p. 394) « activities ranging from the examination of results from state tests to formative assessment in classrooms have all been put under the umbrella of data use » (Datnow & Hubbard, 2015, p. 2) « data use means different things in different contexts. In some cases, data use is defined as actions in which educators draw on a range of data (from formal and information assessments to observations, surveys, and climate data) to inform practice (Jimerson and Wayman 2015). In other contexts, data use is defined as teachers' use of benchmark assessment data (e.g., Blanc et al. 2010). In general, benchmark assessment data tend to predominate in teachers' work with data, in part because many districts have prioritized the use of such data (Datnow and Hubbard 2015). However, data use is not limited to these data. » (Datnow & Hubbard, 2016, p. 10) « Data-driven inquiry frameworks resembles scientific inquiry in process, namely, defining a problem, collecting data, analyzing and interpreting the data, and then making and assessing a decision. Although the ideas behind the various processes are similar, the name is not » (Harshman & Yezierski, 2017, p. 99) « Figure 1. Data-Driven Decision-Making (Department of Education, 2010) This shows a representative data use process, although it does not use the same nomenclature as we do in this review. This cycle includes defining a problem (plan), collecting data (implement and assess), analyzing and interpreting the data (analyze), and making decisions (reflect), similar to scientific inquiry. » (Harshman & Yezierski, 2017, p. 99) « DBDM can be defined as "systematically analyzing existing data sources within the school, applying outcomes of analyses to innovate teaching, curricula, and school performance, and, implementing (e.g., genuine improvement actions) and evaluating these innovations" (Schildkamp & Kuiper, 2010, p.482). » (Hoogland et al., 2016, p. 377) « Establishing a clear purpose for the use of data with regard to improving teaching and learning; data collection; analyzing data to identify learning progress and specific student needs in relation to the goals; interpreting the data to identify possible actions to enhance student learning; taking actions to improve student learning; evaluating the results of those

	actions. This may result in a new cycle of data collection, and a feedback loop is created, making DBDM a cyclic and iterative process. » (Hoogland et al., 2016, p. 378) « DBDM is the general process of collecting ongoing student data and explicitly using the data to modify instruction to improve student performance (Filderman et al., 2018). Also called data-based instruction (Lembke et al., 2018), data-driven decision-making (Datnow & Hubbard, 2016), or data-based individualization (Jung et al., 2018), these models of data collection and analysis vary slightly across approaches but contain the following common steps (Jung et al., 2018; Lembke et al., 2018) that may be repeated as needed: 1. Establish present levels of performance. 2. Set an instructional goal. 3. Deliver instruction. 4. Use data to monitor student progress toward the goal. 5. Use decision rules to evaluate student progress and instructional effectiveness. 6. Hypothesize about the student's progress and instructional needs. 7. Implement changes to instruction. 8. Repeat the cycle. » (Ruhter & Karvonen, 2024, p. 45)

Research-practice partnerships (RPP) or school-university partnerships 9 articles	« RPPs, then, are long-term, mutualistic collaborations between practitioners and researchers that are organized intentionally to investigate problems of practice (Coburn et al., 2013; Tseng, 2017) » (Vetter et al., 2022, p. 2) « Coburn et al. (2013a, b) define research-practice partnerships (RPPs) as “long-term, mutualistic collaborations between practitioners and researchers that are intentionally organized to investigate problems of practice and solutions for improving district outcomes” (p. 2). » (Cooper et al., 2020, p. 2) « Coburn et al. (2013a, b) provide a clear definition of RPPs and according to five criteria: Long-term: RPPs are collaborative arrangements that develop over multiple years, and partners have an open-ended commitment to working together. Focused on problems of practice: RPPs are focused on addressing matters of concern to educators and community partners, rather than solely on developing theory and knowledge. Mutualistic: RPPs address the needs and goals of all partners. Intentionally organized: RPPs have established practices for making decisions together, designing innovations and conducting research together. Produce original analyses: Research to address questions of mutual interest to educators and researchers informs ongoing joint work of the partners. » (Cooper et al., 2020, p. 5) « research–practice partnerships (RPPs), long-term collaborations focused on promoting equitable change in educational systems in which all partners contribute and have a say in research » (Penuel et al., 2020, p. 3) « RPPs can be described as long-term, mutualistic partnerships that produce analyses specifically aimed to address problems of practice » (Sjölund et al., 2022, p. 3) « RPPs have been defined as long-term systematic efforts conducted between researchers and practitioners in collaboration to improve schools and school systems through research (Farrell et al., 2021). To further define RPPs, Coburn et al. (2013, p. 2) describe them as distinct in five ways. Research-practice partnerships: (1) are long-term, (2) focus on problems of practice, (3) are committed to mutualism, (4) use intentional strategies to foster partnership, and (5) produce original analyses. Coburn et al. (2013) further divide RPPs into three categories: Research alliances, Design research, and Networked improvement communities (NICs). The different kinds of partnerships share many similarities, but also

	differences in terms of their primary aims. A Research alliance can be described as a partnership in which participants aim to investigate (not design) policy and programs and then funnel the findings back to practice to inform action. Design research partnerships, on the other hand, aim to design solutions to problems of practice while at the same time studying and improving these solutions. NICs stem from the improvement sciences, and primarily aim not simply to solve a problem of practice but also to improve schools' and districts' capacities to engage in sustained efforts of improvement. » (Sjölund et al., 2023, p. 1492) « Given the problematic nature of the terminology used to describe partnerships between schools and universities that work at school sites to merge research and practice, I will follow the lead of Coburn, Bae, and Turner (2008) and adopt the term insider–outsider partnerships to refer generally to this type of partnership. The term insider signifies members of the school organization (including the district) who partner with members of outside organizations (such as the university) while locating the work of bridging the research–practice gap directly within the school organization [...] the word partnership can be used to refer to different stages of the partnership, such as the initial stage of selecting a partnership, followed by various stages, such as building a collaboration together, designing and implementing reforms, and evaluating, scaling, and sustaining the work. » (Phelps, 2019, p. 5-6) « [we define] research practice partnership (RPP) by following Coburn, Penuel, and Geil (2013) who regard RPPs as "long-term, mutualistic collaborations between practitioners and researchers that are intentionally organized to investigate problems of practice and solutions for improving district outcomes" (p. 2). » (Pereira & Fang, 2022, p. 164) « RPPs are defined as long-term collaborations between practitioners and researchers that are organized to investigate problems of practice and solutions for improving schools and school districts. » (Wei & Huang, 2022, p. 139)

Implementation of evidence-based practices, use of EBP, 6 articles	« EBP is an umbrella term that has been defined as “the integration of the best available research with clinical expertise in the context ” of patient characteristics, culture, and preferences” (American Psychological Association [APA] Presidential Task Force on Evidence-Based Practice, 2006, p. 273). EBPs include not only treatments or interventions, but also assessments, structures, and strategies (e.g., data-based decision making; Kowalski & Lasley, 2009). Determining EBPs in education includes a systematic approach to determining & which programs, interventions, or procedures are supported by a sufficient number of studies that have high methodological quality, use appropriate research designs that allow for an assessment of efficacy, and demonstrate meaningful change among a generalizable sample of participants (Cook et al., 2012). » (Merle et al., 2022, p. 2) « evidence-based practices is defined as a teaching approach, curriculum, or materials, that must be supported by multiple, high-quality, experimental studies demonstrating that the practice has a meaningful impact on student outcomes [6]. The logic in the application of EBPs is that identifying and applying effective instructional practices leads to improved student learning and, ultimately, improved outcomes » (Goddard et al., 2022, p. 2) « teacher experience and judgement were given merit in the evidence-based education equation. In this context, evidence-based education was defined as the synergistic integration of the best available empirical1 evidence and professional wisdom in making decisions about how to deliver instruction » (Dagenais et al., 2012, p. 286)

Use of research, use of research evidence, use of research-based information or academic knowledge utilisation 5 articles	« In relation to frameworks for research use, a common way to categorise this, suggested by Weiss and Bucuvalas (1980), is used with slight variation in several recent articles (Farley-Ripple, 2012; Farrell et al., 2018; Penuel et al., 2017). The framework is divided into four categories of research use: instrumental use of research means that research is used to directly influence a decision; conceptual use of research means that research influences a person or organisation by challenging or supporting existing ideas to extend their perspective; symbolic/political use of research means that research is used to legitimise a decision that has already been made, and as such does not influence the decision-making itself; and process use of research means that the scientific processes of research are used in the work of practice—for instance, school development could be based on inquiry into the school's own organisation, with data collection and analysis. » (Sjölund et al., 2022, p. 5) « • instrumental use (change to concrete practice where research findings are transmitted and applied intact) • conceptual/ enlightenment use (change in understanding or thinking about an issue that affects practice indirectly) • symbolic/strategic/persuasive/legitimising use (use of research findings to influence decisions, justify actions, or support a decision that has already been made). To these three, Levin and Cooper (2012) add a fourth that has emerged in the literature: imposed research use, » (Rycroft-Smith, 2022, p. 34-35) « AKU is conceptualised as the process of finding, selecting and interpreting academic knowledge, translating knowledge into implications for teaching practice, and applying these implications to their own teaching practice. The last step in this process is sharing this knowledge and experiences by using it with others. Literature distinguishes between three types of AKU: 1) instrumental, 2) conceptual and 3) strategic research use (e.g. Ion & Iucu, 2014). Instrumental research use implies a concrete application of research, which has often been translated into a material or usable form and is used to direct specific decisions and/or interventions. Conceptual research use is based on research that may change thinking, but not necessarily change particular actions. Strategic research use involves the use of research as a persuasive or political tool to legitimise a position or practice. » (Schaik et al., 2018, p. 51)

	« When referring to academic knowledge utilisation we mean teachers' use of knowledge generated by researchers in the academic community » (Schaik et al., 2018, p. 57) « From the standpoint of utility or usability, research use gradually evolved into a multifaceted, multidimensional construct comprising not only direct, but also alternative forms of use, as well as non-use, misuse and abuse. Therefore, it cannot be reduced to instrumental use, a direct process where research findings are being transmitted and applied intact (Weiss, 1980). The view of conceptual use of research emerged to underscore the enlightening function of knowledge: it is the 'gradual sedimentation of insights, theories, concepts and ways of looking at the world' (Weiss, 1980: 535). Symbolic or strategic use of knowledge has been suggested to account for the utilisation of research to confirm actual practices. According to Huberman and Gather-Thurler (1991), such use may also turn into knowledge manipulation to derive specific profit or to achieve power goals. » (Dagenais et al., 2012)

Knowledge mobilisation, knowledge brokering, brokerage 2 articles	« the notion of knowledge mobilisation to describe the processes that enable research to be shared and made accessible to others. » (Jones et al., 2022, p. 3) « typically defined as a type of mediation and/ or boundary spanning (e.g., Malin & Brown, 2020) which supports knowledge flow between research, practice and policy in a variety of ways. One of the sources of variety in definition is the wide range of ways in which 'research', 'knowledge', 'use', 'policy' and 'practice' can all be individually interpreted; another distinct issue is the lack of clarity around overarching paradigms used when considering the intention of knowledge brokering and how it interacts with the (perceived) education system » (Rycroft-Smith, 2022, p. 7-9) « important but overlooked characterisation of knowledge broker as exhibitor and knowledge brokering as curating: gathering ideas on a particular theme to tell a particular story and curating them in one place to allow the practitioner to explore and enjoy them as a collection. This has the advantage of conceptualising research ideas, as well as other knowledges, as flexible artefacts that can be used and reused in the co-creation of different stories. However, no one characterisation in this table is 'correct'; they are all useful, and considering them as a whole allows for comparison of the type of complex, overlapping and multidimensional activity knowledge brokering may comprise. » (Rycroft-Smith, 2022, p. 12) « knowledge brokering in education is not well defined, but is often regarded as a process of transforming knowledge from research into practice by crossing or spanning boundaries ; various models and metaphors have been proposed, such as knowledge brokering as mediating, straddling, Janusian integration, boundary blurring, boundary spanning, translation and matchmaking, all with various connotations about the type of work involved ; several frameworks have been proposed to characterise, describe, prescribe, evaluate or measure knowledge brokering, but they often lack detail, clear aims, or a wide perspective of the field » (Rycroft-Smith, 2022, p. 20) « many terms used in the field such as knowledge mobilisation, knowledge translation, knowledge exchange, evidence into-use, evidence-informed practice and (knowledge) brokerage, often used in overlapping ways, which is preventing the field from moving forwards. For this reason, I propose reconciling terms under the umbrella term 'knowledge brokering'. Knowledge brokering in education is not currently well

	defined, but is often characterised as mediation or spanning of boundaries by transforming knowledge and transforming relationships. A variety of models and metaphors have been proposed to capture nuances of meaning within this activity, such as knowledge brokering as mediating, straddling, Janusian integration, boundary blurring, boundary spanning, translation and matchmaking, all with implications about the action, actors and spaces involved. Several frameworks have been proposed to describe, prescribe or measure knowledge brokering, but they often lack detail, purpose or a zoomed-out view of the field as a whole » (Rycroft-Smith, 2022, p. 36) « crucially important function of knowledge brokering: troubling the hierarchies of knowledge and knowers that exist within and around education. » (Rycroft-Smith, 2022, p. 37) « brokerage can be defined as the dynamic interplay of actors when controlling and organizing the flow and content of information » (Rechsteiner et al., 2023, p. 2) « In this paper, we refer to brokers as individuals or groups acting as intermediaries, brokering to activities these actors apply when working the interface (Meyer, 2010), and brokerage as the dynamic and complex set of actors (brokers) and activities (brokering) involved in negotiation processes between distinct social worlds (Stovel & Shaw, 2012). In the following, we refer to the term brokerage when both brokers and brokering or the relation between the two are addressed. » (Rechsteiner et al., 2023, p. 3)
Theory-to-practice gap, research-to-practice gap 2 articles	

Sensemaking 1 article	« Sensemaking is an active search for coherence, aimed at understanding and action » (Goffin et al., 2022, p. 6) « Sensemaking is a process of constructing meaning, forming an understanding, attributing significance (Weick et al., 2005: 'what's the story?'), as well as formulating or taking action (Weick et al., 2005: 'now what?'). Sensemaking can be purely explanatory, that is, aimed at abstract understanding (e.g., making a diagnosis, identifying a problem), and/or anticipatory, that is, aimed at functional understanding (e.g., preparing a scenario for preventing accidents) (Klein et al., 2007, 2010). Ultimately, sensemaking leads to some sort of change, in understanding or behaviour, in beliefs or in actions. In the context of DBDM, this duality is reflected, for instance, in that between conceptual and instrumental uses of data. » (Goffin et al., 2022, p. 6) « Regardless of whether sensemaking is studied at the individual, interpretive level, or at the collective level—for example, in team settings—it is always acknowledged to be a situated and social phenomenon » (Goffin et al., 2022, p. 7)
Research-teaching nexus 1 article	« On the level of implementation, bridging between the two encourages a more participatory approach, one that seeks to understand overlaps between two apparently distinct sets of practices engaged in by teacher educators. In the context of the teacher educator's role, the research-teaching nexus is concerned with professional development: the need to form links within trainees' campus-based teaching, being critical readers of research, and being mediators between academia, schools and the wider community. The six articles in this category, therefore, describe the 'what' and the 'how' of the nexus. » (Wang et al., 2023, p. 11) « What: An emphasis on epistemic connections between research and current school practice, and interconnectedness in research of teaching. » (Wang et al., 2023, p. 11) « conceptualising the research-teaching nexus and three constituent dimensions » (Wang et al., 2023, p. 12) « The cognitive: developing general good practice connected to professional vision » (Wang et al., 2023, p. 12) « The affective: building the efficacy of teacher educators » (Wang et al., 2023, p. 12) « Self-efficacy, through accumulating practical teaching experience » (Wang et al., 2023, p. 12)

	« The research-teaching nexus is a relationship between agents, both teacher educators and pre-service teachers, and research—both research products and research processes within a teaching-learning institution. It forms the foundation of an ITE program's structure. The full panoply of ways in which this nexus is manifest, and its impact enhances the effectiveness and quality of teacher education as well as the learning experience, in both on-campus teaching and school placement practice. » (Wang et al., 2023, p. 15)
Translational research 1 article	« translational research is a systematic approach to turn research knowledge into practical applications. To date, such research has most widely been associated with the field of science and particularly medicine, » (Jones et al., 2022, p. 2) « educational projects which have begun to explore the notion of translational research through teacher-led research, underpinned by social constructivist literature (Vygotsky, 1978) and communities of practice (Wenger 1998; Wenger et al. 2002) where the technology is integrated as a tool of social emancipation for teacher researcher » (Jones et al., 2022, p. 3) « We thus define translational research as: a systematic educational inquiry or investigation, where the findings have been developed by and/or shared effectively with practitioners, with the purpose of informing educational practices. » (Jones et al., 2022, p. 3)
Research dissemination, knowledge dissemination 1 article	

Appendix 4 - Goals for teachers' use of REDaK

	Goal focus
Terms used	**Student**
Social, emotional, and behavioral needs	Meet [their] needs, address student social, emotional, and behavioral (SEB) needs, prevent SEB problems and promote success-enabling factors, encourage appropriate social behavior, preventing and responding effectively to problem behavior, reduce the likelihood of chronic and more intense problem behavior patterns, improvements in social [...] outcomes, minimize behavioural disruptions, student educational progress, support student SEB outcomes in schools, enhance the educational experience « As students with ESN are to make progress in the general education curriculum » (Ruhter et Karvonen, 2024, p. 45)
Academic outcomes	improvements in [...] academic outcomes, raise standards, test score gains, increased test scores, student outcomes, child outcomes, impacting positively on student outcomes « all students stand to benefit academically and socially » (Goddard et al., 2022, p. 1) « Achieving scholarly and social benefits from inclusion » (Goddard et al., 2022, p. 2) « students' academic progress » (Ruhter et Karvonen, 2024, p. 45) « academic performance » (Ruhter et Karvonen, 2024, p. 45) « improve student performance » (Ruhter et Karvonen, 2024, p. 47) « evidence of the impact of DBDM on student outcomes » (Ruhter et Karvonen, 2024, p. 53) « academic achievement » (Shelton et al., 2023, p. 40) « The ultimate goal of PD programs is to improve student outcomes » (Shelton et al., 2023, p. 64) « help all students graduate from high school. » (Penuel et al., 2020, p. 2) « improve student outcomes » (Penuel et al., 2020, p. 4)
Life outcomes	« improved the educational and life outcomes experienced by key stakeholders (e.g., practitioners, students, families) » (Vetter et al., 2022, p. 5) preparing students for the volatile, uncertain, complex and ambiguous (VUCA) future, « functional skills and access to community settings (Browder et al., 2003) rather than attainment of high academic expectations » (Ruhter et Karvonen, 2024, p. 45)

Achievement and success	improvement achievement, positive impact on achievement, enhance the [...] attainment of students « raising student attainment » (Rycroft-Smith, 2022, p. 25) « successful educational experiences for all students » (Grima-Farrell et al., 2011, p. 126) « teacher capacity and ultimately student achievement » (Grima-Farrell et al., 2011, p. 128) « promote new knowledge and enhance the success of individual learners » (Grima-Farrell et al., 2011, p. 129) « foster achievement for all learners » (Grima-Farrell et al., 2011, p. 129) « student achievement » (Marsh, 2012, p. 22) « DBDM can lead to increased student achievement » (Hoogland et al., 2016, p. 377) « positively influence student achievement, as well as district structures and processes » (Cooper et al., 2020, p. 11)
Engagement	Engagement, active participation, « concerned by the disengagement from learning by students » (Hepburn et Beamish, 2019, p. 82) « shared goal, including [...] engaging students through active learning pedagogy » (Phelps, 2019, p. 10)
Learning	learning outcomes, make a difference on students' learning, improved learning, impact learning, feel comfortable using data to determine next steps in learning, feel safe to explore next steps in their work and understand that learning involves ongoing reflection, analysis, and sometimes risk, help learners, enhanced the quality of learning in the classroom, positive effects on students' learning, « student learning » (Goffin et al., 2022, p. 16) « learning of their students » (Harshman et Yezierski, 2017, p. 97) « adopt what is necessary for children to learn » (Goddard et al., 2022, p. 8) « improve both teaching and learning » (Hoogland et al., 2016, p. 377) « adapting teaching and learning activities in order to address student needs and thereby maximize learning » (Hoogland et al., 2016, p. 378) « for the potential to generate positive teaching and learning outcomes » (Cooper et al., 2020, p. 11) « student learning » (Ruhter et Karvonen, 2024, p. 44) « student learning » (Rechsteiner et al., 2023, p. 5) « student learning » (Datnow et Hubbard, 2016, p. 12) « address the literacy needs of ELs. » (Shelton et al., 2023, p. 60)

Equity, diversity and inclusion of students	helping poor children succeed, disrupt [...] patterns of inequity, « respond to the needs of students with disabilities such as learning disabilities, emotional disabilities, and autism spectrum disorders » (Basckin et al., 2021, p. 1) « afford students with disabilities the opportunity to succeed in mainstream classrooms » (Basckin et al., 2021, p. 2) « make classrooms more inclusive » (Grima-Farrell et al., 2011, p. 117) « make the school and classroom environments, and curriculum and materials more responsive to students' backgrounds and learning needs, potentially reducing segregation based on performance levels or perceived abilities » (Grima-Farrell et al., 2011, p. 117) « respond to the needs of all students » (Grima-Farrell et al., 2011, p. 118) « view every learner as valued and essential » (Grima-Farrell et al., 2011, p. 129) « making our classrooms more inclusive » (Grima-Farrell et al., 2011, p. 131) « tailor instruction to their classroom and even to individual students. » (Harshman et Yezierski, 2017, p. 97) « supporting all students in inclusive classrooms. » (Goddard et al., 2022, p. 1) « instruction suited to their needs » (Goddard et al., 2022, p. 1) « providing effective instruction in inclusive settings » (Goddard et al., 2022, p. 1) « adapting teaching and learning activities in order to address student needs and thereby maximize learning » (Hoogland et al., 2016, p. 378) « become more in tune with their students' perspectives, needs and motivations » (Phelps, 2019, p. 2) « evolve more fine-grained information about student achievement that will allow teachers to address students' individual needs » (Datnow et Hubbard, 2016, p. 23) « more students getting the instruction and intervention they require » (Shelton et al., 2023, p. 64)
	Teacher
Learning environment	maintain safe and productive learning environments, positive, structured, supportive and productive classroom; procedures that work in classrooms, « provide learning environments that adapt to the needs of all students » (Rechsteiner et al., 2023, p. 2)

Teaching, practice and instruction	influence practice, shape practice, inform (instructional) practice, improve the quality of teaching, deepen the interpretive frames and references [used] to guide instructional practice, inform instructional decision making, inform ongoing instructional or curricular improvements, maximise instructional time, improve classroom instruction, improve educational practices, improving teaching practice, impact teaching, impact practice, widespread positive impact on practice, changes in practice, instructional changes, support teaching, enhancing lives through education, raise standards, inform how teachers plan lessons, identify concepts for reteaching, and differentiate instruction; solving practical problems, ensure that classrooms function effectively, « instructional change and improvement » (Goffin et al., 2022, p. 20) « inform teaching » (Harshman et Yezierski, 2017, p. 97) « inform instruction. » (Harshman et Yezierski, 2017, p. 98) « positively impact their instruction » (Harshman et Yezierski, 2017, p. 98) « appropriately guide their instruction » (Harshman et Yezierski, 2017, p. 103) « improve both teaching and learning » (Hoogland et al., 2016, p. 377) « instructional improvement » (Hoogland et al., 2016, p. 382) « instructional and/or curricular improvements based on data, for example, instructional differentiation » (Hoogland et al., 2016, p. 382) « effectiveness as teachers » (Phelps, 2019, p. 2) « inform academic instruction » (Ruhter et Karvonen, 2024, p. 45) « inform instruction » (Ruhter et Karvonen, 2024, p. 52) « guide instruction » (Ruhter et Karvonen, 2024, p. 54) « improve educational practice » (Rechsteiner et al., 2023, p. 2) « improve practice on an individual and collective level » (Rechsteiner et al., 2023, p. 2) « improve instruction » (Datnow et Hubbard, 2016, p. 8) « improve whole-class literacy instruction » (Shelton et al., 2023, p. 61) « impact practice » (Penuel et al., 2020, p. 2) « inform their decision-making » (Penuel et al., 2020, p. 4)
Diagnostic and formative evaluation	« evaluate student progress » (Ruhter et Karvonen, 2024, p. 52) « identify the misconceptions students hold, and based on their PCK, they can determine how to alter their instruction accordingly » (Hoogland et al., 2016, p. 382) « help identify the specific content area in which students are struggling the most. » (Harshman et Yezierski, 2017, p. 99) « isolate the detailed, specific learning objective not met by the students » (Harshman et Yezierski, 2017, p. 99) « the primary reason that teachers analyze and interpret assessment results is to identify the content area(s) on which students perform poorly. » (Harshman et Yezierski, 2017, p. 104)

Social justice teaching	« improve instruction for students with disabilities » (Basckin et al., 2021, p. 3) « Thus, justice-oriented pedagogy focuses on teaching about power, oppression, and privilege and supporting others to make changes that promote equity (Bell, 1997; Hytten & Bettez, 2011; Sensoy & DiAngelo, 2017). » (Vetter et al., 2022, p. 7 "« support students with and without disabilities. » (Goddard et al., 2022, p. 1) « prioritize instructional time, better target instruction towards students' individual needs, and refine instructional methods » (Datnow et Hubbard, 2016, p. 8)
Teachers' professional development	gaining advanced qualifications, promotion, cultivate professional performance, better professional knowledge about [...] effective teaching and learning, inform continuous improvement, positive impact on teachers' learning, learning as a continual process, supplying teachers with the capacity to investigate and improve their own practice, improve the quality of teacher education, increasing practitioners' capacity for improvement, promising model [...] that practitioners are meant to learn, individual teacher development, multi-dimensional professional learning, support teachers and what they will authentically value and need from research, effectively supporting teachers, « teacher capacity and ultimately student achievement » (Grima-Farrell et al., 2011, p. 128) « the nexus is an analytical tool to reconceptualise professional practice » (Wang et al., 2023, p. 11) « accumulating practical teaching experience » (Wang et al., 2023, p. 12) « shared goal, including the goal of professionalizing the teacher's role in the classroom [...] » (Phelps, 2019, p. 10) « collaboration and professional development is enhanced » (Rechsteiner et al., 2023, p. 2) « positive changes in teacher knowledge and practice » (Shelton et al., 2023, p. 58) « teachers will be equipped with improved knowledge, beliefs, and skills to support the literacy needs of ELs » (Shelton et al., 2023, p. 64)
Teachers' reflexivity	challenge assumptions on teaching and learning, understand learning processes, think critically about their teaching and to improve it, stimulate and satisfy their intellectual curiosity, looking for answers to 'practical and professional concerns', « achieving harmony between what trainees have learnt from researching and the real social context, cognitively, affectively and self-efficaciously. » (Wang et al., 2023, p. 12)

Teachers beliefs, dispositions and emotions	feel safe to explore next steps in their work and understand that learning involves ongoing reflection, analysis, and sometimes risk; feel comfortable using data to determine next steps in instruction, teacher comfort with data, « change teacher beliefs and attitudes, and engagement with research may increase. » (Rycroft-Smith, 2022, p. 25) « practitioners have reported increased self-confidence and enthusiasm for their work and general improved feelings of community following network-related interaction » (Cooper et al., 2020, p. 11) « teachers and their sense of ownership over their school and classroom » (Phelps, 2019, p. 2)
Teacher autonomy	« One of the biggest tensions inherent in educational knowledge brokering to support research use in practice is the potential conflict between short- and long-term goals, which may also be conceptualised as the tension between impact and teacher autonomy. » (Rycroft-Smith, 2022, p. 35) « Do we want the best-quality research (presuming we can agree on such a thing) to reach teachers as fast as possible in as concise as format as possible and in the most accessible language possible, so they can use it now; or do we want to spend more time and resource building in capacity (and potential obsolescence) into the knowledge brokerage function so that teachers can critically appraise research without brokering—or without brokers, variously—in the future? » (Rycroft-Smith, 2022, p. 35)
Research	implementation of research methods and methodologies, trying out ideas from research to critically evaluating their consequences, put context-centredness at the heart of a more expansive teacher research agenda « opening up the black box of research to teachers » (Rycroft-Smith, 2022, p. 35) « value and use educational research » (Phelps, 2019, p. 2)
Collaboration	improved teacher dialogue, teacher collaboration, « aims for knowledge brokering activity—agreed by stakeholders, not done to them » (Rycroft-Smith, 2022, p. 24) « the value of building relationships with practitioners for the authentic, complex and skill-building opportunities of working with schools (Ralston et al., 2016a, b), and for the potential to generate positive teaching and learning outcomes » (Cooper et al., 2020, p. 11) « engage in true genuine dialogue built on qualities such as humility, faith, and hope, and that ultimately gives voice and power to all parties involved. Voice and power can take many forms in a collaboration, including feeling legitimized by the collaboration, feeling joint ownership of the collaboration, and

	having an openness to being transformed by the collaboration. » (Phelps, 2019, p. 12) « collaboration and professional development is enhanced » (Rechsteiner et al., 2023, p. 2)
To avoid	« Without evaluating the effectiveness of knowledge brokering, we risk work taking place that may be poor quality, careless and ineffective; but also politicised, highly biased, unethical and/or actively do harm » (Rycroft-Smith, 2022, p. 23)
Other	overcome teachers' resistance, « Under instrumental performance, the notion of "good teaching" is argued to consist of achieving pre-specified targets that are however, "ideological construction which serves the purpose of hierarchically controlling performance" (Elliott, 1989a, p. 19). This is problematic as "objectivity", "rationale", and "honesty" performance indicators presuppose a value perspective expressed in judgements about qualitative aspects of performance which are not purely technical » (Pereira et Fang, 2022, p. 158) Teacher agency
	System
School outcomes	School outcomes, school performance, measurable outputs,
School and system improvement	(continual) school improvement, bring the education system up to speed in synchrony with the demands of a rapidly changing society, improve school practices, improve education, improve instruction, improve schools and school systems, improve schools' and districts' capacities to engage in sustained efforts of improvement, progressive education, adapt in order to be more effective, develop a critical framework through which teachers themselves critique and challenge the influences and forces that prevail negatively upon classrooms, schools need to evolve [regarding their] research culture, « school improvement » (Goffin et al., 2022, p. 3) « inform subsequent policy and instructional decisions » (Goffin et al., 2022, p. 3) « develop capacity for sustaining and expanding innovation » (Vetter et al., 2022, p. 19) « school improvement » (Cooper et al., 2020, p. 1) « impact in K-12 education systems » (Cooper et al., 2020, p. 2) « create substantive change in large scale systems » (Cooper et al., 2020, p. 6) « positively influence student achievement, as well as district structures and processes » (Cooper et al., 2020, p. 11) « improve the education system » (Cooper et al., 2020, p. 15)

	« high-quality school improvement » (Rechsteiner et al., 2023, p. 2) « school improvement planning » (Datnow et Hubbard, 2016, p. 8) « influence organizational learning » (Datnow et Hubbard, 2016, p. 8) « educational improvement » (Penuel et al., 2020, p. 5) « system-wide improvement » (Penuel et al., 2020, p. 16)
Educational professionals improvement	better professional knowledge about the management of schools, credence and status [with] limited investment of time and effort, « increasing probability literacy, and supporting the development of critical and informed stakeholders at all levels of education » (Rycroft-Smith, 2022, p. 40) « improved the educational and life outcomes experienced by key stakeholders (e.g., practitioners, students, families) » (Vetter et al., 2022, p. 5)
Foster collaboration	bring research and practice closer together in collaborative approaches to school development and research, collegial culture, reciprocal learning, researchers and teachers' mutual learning, build close links between research, policy and practice, « building organizational infrastructure, shared meaning, and trusting relationships together » (Phelps, 2019, p. 6) « connect otherwise disconnected actors to facilitate staff interactions » (Rechsteiner et al., 2023, p. 21)
School and system equity, diversity and inclusion	contestation and plurality of voices in classrooms and schools, supporting educational futures that are truly inclusive, where the status quo is challenged and changed, by and for teachers; designing educational futures must be inclusive and place learners and teachers at the heart of the process « progress of inclusion in schools » (Grima-Farrell et al., 2011, p. 118) « Framing Social Justice [...] A key element of social justice is advancing equity for all » (Vetter et al., 2022, p. 6) « Upholding the rights of students requires disrupting the resegregation of schools (Orfield & Jarvie, 2020; Wells et al., 2019), addressing inequitable funding for students of poverty and students of color (Morgan & Amerikaner, 2018), eliminating the inequitable distribution of effective teachers (Goldhaber et al., 2018; Lai et al., 2021; Sykes & Martin, 2019), and vanquishing microaggressions (Compton-Lilly, 2020). » (Vetter et al., 2022, p. 6) « examine topics related to equitable structures of RPPs and ways to equitably address problems of practice in schools. » (Vetter et al., 2022, p. 14) « greater equity and distribution of power as goals. » (Vetter et al., 2022, p. 18-19)

	« If educational improvement is inequitable, it is not improvement at all. » (Vetter et al., 2022, p. 20) « Partnerships may need to engage in explicit conversations about power inequities that affect partnership relationships and joint work, if they are to arrive at a mutually beneficial focus for shared work (Denner et al., 2019). These conversations may include special attention to the dynamics of race, ethnicity, gender, or other markers that reflect historical disenfranchisement in educational decisions (Vakil et al., 2016) » (Penuel et al., 2020, p. 10)
Facilitate change	better understand, inform, shape and reshape standard school practices, inform decision making, overcome long-standing challenges, inspiring transformation through the enhancement of deep multifaceted communication on shared objects and scripts, provide feedback, educational change, enhanced individual and organisational learning and change,
System values	replace traditional, liberal values with the values of 'what works', reflect on the dominant rules, schedules, or norms, « disrupted long-standing power differentials between researchers and practitioners » (Vetter et al., 2022, p. 5)
	Knowledge
Equity-oriented	achieving a more democratised evidence system, more even distribution of authority in the creation of educational evidence, knowledge sharing and collegiality, equity relations, « troubling the hierarchies of knowledge and knowers that exist within and around education » (Rycroft-Smith, 2022, p. 37)
Teacher-oriented	investigate (not design) policy and programs and then funnel the findings back to practice to inform action, design solutions to problems of practice while at the same time studying and improving these solutions, solve a problem of practice, help shape the design and delivery of educational offerings in the future,
Knowledge-oriented	building new scientific hypotheses, co-generated knowledge linking research with practice, understand rather than to control and predict the human world, add to the knowledge base of how students learn in different kinds of situations, « producing new knowledge through the activity of knowledge brokering » (Rycroft-Smith, 2022, p. 38) « shared goal, including [...] conducting action research on specific curricular issues » (Phelps, 2019, p. 10)

Appendix 5 - Detailed coding procedure

Step 0: Reading of the review documents.

Step 1: Creation of meaning units

The first author selected units of meaning, retaining as such passages that reflect a suggested change (see definition above), passages that reflect the perceived usefulness of a specific element of the current synthesis and comments related to grammar or spelling mistakes, or corrections which could be judged as consensual. We excluded content that should not be taken into account for this analysis, for instance because it expresses rephrasing of participants' understanding, or unclear elements that could not be interpreted as suggested changes.

Step 2: Condensing meaning units

Condensing units of meaning involves transforming the meaning unit into a more synthetic form, while limiting interpretation and striving to lose as little information as possible. It sometimes included rephrasing to make explicit the suggested change when it was only implicit in the meaning unit. We only condensed meaning units related to suggested changes, and separated the other meaning units in two categories: (1) 'perceived usefulness', which accounts for comments on appreciated features of the initial resource but didn't express any suggested change and (2) 'corrections', for comments related to grammar or spelling mistakes, or simple elements which could be judged as consensual. When necessary, we added a note of clarification reflecting the first author's interpretation where the meaning unit seemed too vague to be understood independently of any interpretation, or referring to a professional vocabulary, specific acronym, a resource or an external link. Reviewers having written comments requiring clarification were invited to develop or to reformulate such passages, and only the final version was included in the analysis.

Step 3: Coding

A unique code was assigned to each meaning unit from the list of existing codes or created if none seemed to match.

Step 4: Code improvement

We revised and redefined the various codes so that they best described the data.

Step 5: Categorization

We grouped codes into several more abstract categories.

All these steps were followed iteratively, i.e., the addition of new review documents was done one after the other. Particular attention was paid to “negative cases” or data threatening the emerging theory as new texts were coded, and where necessary all codes or categories were changed, notably following recommendations from the other authors of this article.

Appendix 6- Sorted content-related groups of suggested changes

	Judgement	Priority	Filled or empty	Integration
1	ATQ + ACRA	High	Filled	Integrated
2	ACRA + DJ	Medium	Empty	Integrated and For another version
3	Accepter tel quel (ATQ)	Medium	Filled	Integrated
4	None	Low	Empty	Integrated
5	ATQ + DJ	High	Empty	Integrated and For another version
6	ACRA + DJ	Medium	Filled	Integrated
7	ATQ + ACRA	Medium	Filled	Integrated
8	Accepter tel quel (ATQ)	None	Empty	Integrated
9	ATQ + DJ	Medium & Low	Filled	Rejected
10	Accepter tel quel (ATQ)	None	Empty	Rejected
11	Difficile de juger (DJ)	Low	Empty	Integrated
12	Accepter tel quel (ATQ)	None	Empty	Integrated
13	EJ + DJ	Low	Filled	Rejected
14	ATQ + DJ	None	Empty	Rejected
15	Écarter et justifier (EJ)	None	Empty	For another version
16	Accepter tel quel (ATQ)	Medium	Empty	Integrated
17	ACRA + DJ	Low	Empty	Rejected
18	ATQ + DJ	Medium	Empty	Integrated
19	Difficile de juger (DJ)	Low	Filled	Rejected
20	ATQ + DJ	High	Empty	Integrated
21	ACRA + DJ	Low	Filled	Rejected
22	Accepter tel quel (ATQ)	High	Empty	Integrated
23	Accepter tel quel (ATQ)	None	Empty	Integrated
24	Accepter tel quel (ATQ)	None	Empty	Integrated
25	ACRA + DJ	Low	Empty	Rejected
26	Accepter tel quel (ATQ)	None	Empty	Integrated
27	Accepter tel quel (ATQ)	Medium	Empty	Rejected
28	Accepter tel quel (ATQ)	None	Empty	Rejected
29	Accepter tel quel (ATQ)	None	Empty	For another version
30	ATQ + ACRA + DJ	Medium	Filled	Integrated and Rejected
31	ATQ + ACRA	High	Empty	Integrated

32	Accepter tel quel (ATQ)	None	Empty	Rejected
33	Accepter tel quel (ATQ)	None	Empty	Rejected
34	ATQ + DJ	None	Empty	Rejected
35	ACRA + DJ	High	Filled	Integrated
36	ATQ + EJ	High	Empty	Integrated
37	Accepter une clarification / reformulation / alternative (ACRA)	Low	Filled	Rejected
38	ATQ + DJ	Medium	Filled	Integrated
39	Accepter tel quel (ATQ)	None	Empty	Integrated
40	Accepter une clarification / reformulation / alternative (ACRA)	Low	Filled	Integrated
41	Accepter tel quel (ATQ)	None	Empty	Rejected
42	Accepter tel quel (ATQ)	None	Empty	Integrated
43	Accepter tel quel (ATQ)	None	Empty	Rejected
44	Accepter tel quel (ATQ)	None	Empty	Rejected
45	ATQ + DJ	Medium	Filled	Integrated
46	ATQ + DJ	None	Empty	Integrated and Rejected
47	Accepter tel quel (ATQ)	None	Empty	Integrated
48	ACRA + EJ	High	Filled	Integrated and Rejected
49	Difficile de juger (DJ)	Low	Empty	Rejected
50	Accepter tel quel (ATQ)	None	Empty	Rejected
51	ACRA + DJ	Medium & Low	Filled	Integrated
52	Accepter tel quel (ATQ)	None	Empty	Integrated
53	Accepter tel quel (ATQ)	Medium	Empty	Integrated and Rejected
54	ATQ + DJ	Low	Filled	Integrated and Rejected
55	EJ + DJ	None	Filled	Rejected
56	ATQ + EJ + DJ	Low	Filled	Integrated
57	ATQ + DJ	None	Filled	Integrated
58	Accepter tel quel (ATQ)	None	Empty	Integrated
59	ATQ + DJ	None	Empty	Rejected
60	Accepter tel quel (ATQ)	None	Empty	Rejected
61	Accepter tel quel (ATQ)	None	Empty	Integrated
62	Accepter tel quel (ATQ)	None	Empty	Rejected

63	ATQ + ACRA + DJ	Medium & Low	Empty	Integrated and For another version
64	ACRA + DJ	High	Filled	Integrated
65	Accepter tel quel (ATQ)	None	Empty	Rejected
66	ATQ + EJ	Medium	Filled	Rejected
67	ACRA + DJ	Low	Empty	Integrated and For another version
68	ACRA + DJ	Medium	Filled	Integrated
69	Accepter tel quel (ATQ)	None	Empty	Integrated
70	Accepter tel quel (ATQ)	Low	Empty	Rejected
71	ATQ + DJ	Low	Empty	Rejected
72	Accepter tel quel (ATQ)	None	Empty	Rejected
73	Accepter tel quel (ATQ)	None	Empty	Rejected
74	Écarter et justifier (EJ)	Low	Empty	Rejected
75	Accepter tel quel (ATQ)	None	Empty	Rejected
76	ATQ + EJ	None	Empty	Rejected
77	ACRA + DJ	Medium	Empty	Integrated
78	EJ + DJ	None	Filled	Rejected
79	ATQ + EJ	None	Filled	Rejected
80	ATQ + DJ	Low	Empty	Rejected
81	ATQ + DJ	Medium	Empty	Rejected
82	ACRA + EJ	Low	Filled	Rejected
83	Accepter tel quel (ATQ)	None	Empty	Integrated
84	ATQ + DJ	High	Empty	Integrated
85	ATQ + DJ	Medium	Empty	Integrated
86	Accepter tel quel (ATQ)	None	Empty	Rejected
87	Accepter tel quel (ATQ)	None	Empty	Rejected
88	ACRA + DJ	High	Filled	Integrated and Rejected
89	ATQ + DJ	Medium	Empty	Rejected
90	EJ + DJ	None	Filled	Rejected
91	ATQ + DJ	High	Filled	Integrated
92	Accepter tel quel (ATQ)	None	Filled	Integrated
93	ATQ + DJ	High	Empty	Integrated
94	ATQ + ACRA + DJ	Medium	Filled	Integrated
95	Accepter tel quel (ATQ)	None	Empty	Integrated
96	ACRA + DJ	None	Empty	Rejected
97	ATQ + DJ	None	Empty	Integrated and For another version

98	Accepter tel quel (ATQ)	None	Empty	Integrated
99	Accepter tel quel (ATQ)	High	Empty	Integrated
100	ATQ + DJ	None	Empty	Integrated
101	Accepter tel quel (ATQ)	None	Empty	Integrated
102	ATQ + ACRA	High	Empty	Rejected
103	ATQ + DJ	Medium	Empty	Rejected
104	Accepter tel quel (ATQ)	High	Empty	Integrated
105	Accepter tel quel (ATQ)	None	Empty	Integrated and For another version
106	ACRA + EJ + DJ	None	Empty	For another version and Rejected
107	Difficile de juger (DJ)	None	Empty	Integrated
108	ATQ + DJ	High	Empty	Rejected
109	Accepter tel quel (ATQ)	None	Empty	For another version
110	Accepter tel quel (ATQ)	None	Empty	Integrated
111	Accepter tel quel (ATQ)	None	Empty	Integrated
112	ATQ + DJ	None	Empty	Rejected
113	ATQ + DJ	High	Empty	Rejected
114	Accepter tel quel (ATQ)	None	Empty	Integrated
115	ACRA + DJ	None	Filled	Rejected
116	Accepter une clarification / reformulation / alternative (ACRA)	Medium	Filled	Integrated
117	Accepter tel quel (ATQ)	None	Empty	Integrated
118	ATQ + ACRA	High	Filled	Integrated and Rejected
119	ATQ + DJ	None	Empty	Rejected
120	Accepter tel quel (ATQ)	None	Empty	Rejected
121	ATQ + DJ	None	Empty	Integrated
122	ATQ + DJ	Medium	Empty	Rejected
123	ATQ + DJ	None	Empty	Integrated
124	ACRA + DJ	None	Empty	Integrated
125	ACRA + DJ	None	Empty	Integrated
126	ACRA + DJ	High	Empty	Integrated
127	ATQ + DJ	None	Empty	Integrated
128	EJ + DJ	None	Empty	Rejected
129	EJ + DJ	Medium	Empty	Rejected
130	Accepter tel quel (ATQ)	None	Empty	Integrated
131	ACRA + DJ	High	Empty	Integrated
132	Accepter tel quel (ATQ)	None	Empty	All three

133	Difficile de juger (DJ)	None	Empty	Rejected
134	Accepter tel quel (ATQ)	None	Empty	Integrated and Rejected
135	ACRA + DJ	High	Filled	Integrated
136	Accepter tel quel (ATQ)	None	Empty	Integrated
137	Accepter tel quel (ATQ)	None	Empty	Integrated
138	Accepter tel quel (ATQ)	None	Empty	For another version
139	Accepter tel quel (ATQ)	None	Empty	Integrated
140	Accepter tel quel (ATQ)	None	Empty	Integrated
141	ACRA + DJ	High	Filled	Rejected
142	Accepter tel quel (ATQ)	None	Empty	Integrated
143	Accepter tel quel (ATQ)	None	Empty	Integrated
144	ATQ + DJ	High	Empty	Integrated
145	ACRA + DJ	High	Filled	Rejected
146	ACRA + DJ	Low	Filled	Integrated
147	Accepter tel quel (ATQ)	None	Empty	Integrated
148	EJ + DJ	None	Filled	Integrated
149	Accepter tel quel (ATQ)	None	Empty	Rejected
150	Accepter tel quel (ATQ)	None	Empty	Integrated
151	Écarter et justifier (EJ)	None	Filled	Rejected
152	Accepter tel quel (ATQ)	None	Empty	Rejected
153	Accepter tel quel (ATQ)	None	Empty	Rejected
154	Accepter une clarification / reformulation / alternative (ACRA)	High	Filled	Rejected
155	Accepter tel quel (ATQ)	None	Empty	Integrated
156	Accepter une clarification / reformulation / alternative (ACRA)	None	Filled	Rejected
157	Accepter tel quel (ATQ)	None	Empty	Rejected
158	Écarter et justifier (EJ)	None	Filled	Rejected
159	Accepter une clarification / reformulation / alternative (ACRA)	High	Filled	Rejected
160	Accepter une clarification / reformulation / alternative (ACRA)	Medium	Filled	Integrated
161	Accepter tel quel (ATQ)	High	Empty	Integrated
162	Accepter tel quel (ATQ)	Low	Empty	Rejected
163	Accepter tel quel (ATQ)	None	Empty	Rejected
164	Accepter tel quel (ATQ)	None	Empty	Rejected

165	Difficile de juger (DJ)	Low	Filled	Rejected
166	Difficile de juger (DJ)	None	Empty	Rejected
167	Accepter tel quel (ATQ)	Medium	Empty	Integrated
168	Accepter tel quel (ATQ)	None	Empty	Rejected
169	Accepter tel quel (ATQ)	None	Empty	Integrated
170	Accepter tel quel (ATQ)	None	Empty	Rejected
171	Accepter tel quel (ATQ)	None	Empty	Rejected
172	Accepter tel quel (ATQ)	None	Empty	Integrated
173	Accepter tel quel (ATQ)	None	Empty	Integrated
174	ATQ + ACRA + DJ	Medium	Filled	Rejected
175	Accepter tel quel (ATQ)	None	Empty	Integrated
176	Écarter et justifier (EJ)	None	Filled	Rejected
177	Accepter tel quel (ATQ)	None	Empty	Integrated
178	Accepter tel quel (ATQ)	None	Empty	Rejected
179	Accepter tel quel (ATQ)	None	Empty	Rejected
180	Accepter tel quel (ATQ)	None	Empty	Rejected
181	Accepter tel quel (ATQ)	None	Empty	Rejected
182	Accepter tel quel (ATQ)	None	Empty	Rejected
183	Accepter tel quel (ATQ)	None	Empty	Rejected
184	Accepter une clarification / reformulation / alternative (ACRA)	Medium	Filled	Rejected
185	Accepter tel quel (ATQ)	None	Empty	Rejected
186	Accepter une clarification / reformulation / alternative (ACRA)	Medium	Filled	Rejected
187	Accepter tel quel (ATQ)	None	Empty	Rejected
188	Accepter tel quel (ATQ)	None	Empty	Rejected
189	Accepter tel quel (ATQ)	None	Empty	Integrated
190	Accepter tel quel (ATQ)	None	Empty	Integrated and For another version
191	ACRA + DJ	None	Filled	Integrated
192	Accepter tel quel (ATQ)	None	Empty	Integrated
193	Accepter tel quel (ATQ)	None	Empty	Integrated
194	Accepter tel quel (ATQ)	None	Empty	Integrated
195	Accepter une clarification / reformulation / alternative (ACRA)	Medium	Filled	Integrated
196	ATQ + ACRA	High	Filled	Integrated
197	Difficile de juger (DJ)	None	Filled	Rejected

198	Accepter tel quel (ATQ)	None	Empty	Rejected
199	Accepter tel quel (ATQ)	None	Empty	Integrated
200	Écarter et justifier (EJ)	None	Filled	For another version
201	Accepter une clarification / reformulation / alternative (ACRA)	Medium	Filled	Integrated and For another version
202	ATQ + DJ	None	Filled	Integrated
203	Accepter tel quel (ATQ)	High	Empty	Integrated
204	Accepter une clarification / reformulation / alternative (ACRA)	Medium	Filled	Integrated and For another version
205	Difficile de juger (DJ)	None	Filled	For another version and Rejected
206	Difficile de juger (DJ)	None	Filled	Rejected

Appendix 7 - Survey questions (english version)

Background and purpose of the study

The aim of this form is to collect data for research purposes, in order to better **understand the motivations and obstacles to the participation of teachers and researchers in** collaborative research. This work is being carried out as part of Pleen le Jeune's thesis [1], in connection with a collaborative research process aimed at improving a synthesis of research on critical thinking education developed by the ÉPhiScience association (hereinafter “the synthesis").

Whether you took part or not, here's a summary of the steps in this collaborative research process.

The first step (up to February 2023) consisted in collecting notes from several people to review the synthesis.

The second step (until June 2023) involves taking part in collaborative workshops to identify concrete actions to meet the challenges of critical thinking education, in connection with the synthesis. This second step follows the Profs-Chercheurs approach (more info at https://profschercheurs.org).

The third step (in April-May 2023) involves taking part in one of three meetings designed to guide the rewriting of the new version of the synthesis based on collegial and justified decisions.

You'll find a summary of the various steps in the process in this diagram.

Questionnaire structure and duration

The questionnaire has 4 sections about your perception of :

1. Participation in research in general
2. Rereading the summary
3. Teacher-researcher workshops
4. The rest of the synthesis improvement process

We estimate the time required to complete this questionnaire at **ten minutes**.

RGPD and participants' rights

By accessing the rest of the questionnaire, you certify that you understand that the data collected by this questionnaire will be stored in a computerized file by Université Grenoble Alpes and processed for research purposes. This data will be accessible to the researchers involved in this project and will be kept for a period of two years after the publication of the last scientific work related to this project. The data will then be anonymized, archived and made available to the scientific community for research purposes. Raw data will be kept strictly confidential and no personal data will be analyzed or shared.

Contact the lead author of this study at nathanael.jeune@cri-paris.org to exercise your right of access, rectification, opposition, limitation, erasure and portability of your data, in accordance with Regulation (EU) 2016/679 of April 27, 2016. You may withdraw your consent to the processing of your data at any time without having to present any justification.

[1] Université Grenoble Alpes, Learning Planet Institute, Université Paris Cité, you can contact me at: nathanael.jeune@cri-paris.org

Section 0: Validation of participation

Name

Email

How did you hear about the research project to improve the synthesis of critical thinking education? (free text)

Consent to the use of data for research purposes

- Yes
- No (redirects to question 5)

Section 1: General perception of research participation

In an imaginary situation where you are invited to participate in certain steps of a research project (e.g., defining a research question, collecting and analyzing data, etc.), this questionnaire asks you to **give your opinion on what might influence your possible participation in these steps of the research project**. There are no right or wrong answers.

QUESTION 1a

For each of the following statements, we ask you to indicate the extent to which you agree or disagree using the 7-point scale below.
The scale runs from -3 to +3 where :
-3 means “strongly disagree
-2 corresponds to “moderately disagree”.
-1 corresponds to “slightly disagree”.
0 corresponds to “neither agree nor disagree”.
1 corresponds to “weakly agree”.
2 corresponds to “moderately agree
3 corresponds to “strongly agree”.

Self-efficacy beliefs

- I need to feel I have the necessary skills and legitimacy to take part in these steps of the research project.

Context beliefs

- The purpose and objectives of my participation in these steps of the research project must be clear and precise.
- The time I need to take part in these steps of the research project must be sufficiently short.
- The period of time over which the opportunity to participate in these steps of the research project is extended must be sufficiently long.
- I need to be able to choose when I collaborate and when I work independently in these steps of the research project.

Teacher attitude towards research

- The results of the project, or what I learn during my participation in these steps of the research project, should be useful to me.
- My participation in these steps of the research project should not be difficult or stressful.

- My participation in these steps of the research project must be pleasant or interesting.

Teachers motivations to do research

- My participation in these steps of the research project must come from personal motivation (e.g. an interest in the subject).
- My participation in these steps of the research project must come from external motivations (e.g. a reward or obligations related to my job).

QUESTION 1b

Would you like to add anything about what you think could play a role in facilitating or enabling your contribution to certain steps of a research project? (free text optional)

Section 2 - Perception of the synthesis review step

In this section, “this step of the research project” refers to the work of proofreading and note-taking concerning the synthesis of research on critical thinking education. We invite you to judge **the situation as you see it**. There are no right or wrong answers.

QUESTION 2a

Have you been informed about the possibility of participating in the review step of the research synthesis on critical thinking education? ● Yes, and I've already taken part ● Yes, but I didn't know how to participate ● Yes, but I wasn't able to participate ● No (does not display 2b and 2c)

QUESTION 2b

In the case of **rereading the research synthesis on critical thinking education, whether you participated or not**, for each of the following statements, we ask you to specify the extent to which you agree or disagree using the 7-point scale below.

The scale runs from -3 to +3 where :

-3 means “strongly disagree

-2 corresponds to “moderately disagree”.

-1 corresponds to “slightly disagree”.

0 corresponds to “neither agree nor disagree”.

1 corresponds to “weakly agree”.

2 corresponds to “moderately agree

3 corresponds to “strongly agree”.

Self-efficacy beliefs

- I think I had (or would have had) the skills and legitimacy to make a useful contribution to this step of the research project.

Context beliefs

- I believe that the aim and objectives of this step of the research project were clear and precise.
- I think that the time I had to (or should have) taken to contribute to this step of the research project was (or would have been) sufficiently short.
- I think that the period of time over which the opportunity to contribute to this step of the research project extended was sufficiently long.
- I think I could have (or would have) chosen the times when I collaborated and worked independently to contribute to this step of the research project.

Teacher attitude towards research

- I believe that the outcome of the project or what I learned during my contribution to this step of the research project was (or would have been) useful to me.
- I don't think my contribution to this step of the research project was (or would have been) difficult or stressful.
- I think my contribution to this step of the research project was (or would have been) pleasant or interesting.

Teachers motivations to do research

- I think I had (or would have had) personal motivations (e.g. an interest in the subject) to contribute to this step of the research project.
- I think I had (or would have had) external motivations (e.g. a reward or obligations related to my job) to contribute to this step of the research project.

QUESTION 2c - Free addition

Would you like to add anything about what has (or could have) facilitated or enabled your contribution to this step of the research project? (free text optional)

Section 3 - Ateliers Profs-Chercheurs

In this section, “this step of the research project” refers to **participation in the** Profs-Chercheurs community's **collaborative research workshops** on critical thinking education. We invite you to judge **the situation as you see it**. There is no right or wrong answer.

QUESTION 3a

Have you been informed about the possibility of taking part in the Profs-Chercheurs community workshops on critical thinking education? ● Yes, and I've already taken part ● Yes, but I don't know how to participate (see info 3a bis). ● Yes, but I haven't taken part yet (see info 3a bis). ● No (does not display 3b and 3c)

INFO 3a bis

To take part in collaborative research workshops within the Profs-Chercheurs community on critical thinking education, simply register using the form available here: https://www.profschercheurs.org/fr/contribuer
Workshops are organized on a regular basis and dates are communicated to registered community members. It is also possible to request a customized workshop on a specific date that suits you and when other community members are available.
For more information on the Profs-Chercheurs program, please visit www.profschercheurs.org.
The Profs-Chercheurs community on critical thinking education was created by the ÉPhiScience association: https://ephiscience.org/

QUESTION 3b

In the case of **participation in the Profs-Chercheurs community workshops on critical thinking education**, whether you participated or not, to what extent do you agree with the following statements? (likert from “strongly disagree” to “strongly agree” + I don't know)

Self-efficacy beliefs

- I believe I have the skills and legitimacy to make a useful contribution to this step of the research project.

Context beliefs

- I believe that the aim and objectives of this step of the research project are clear and precise
- I think the time I have to contribute to this step of the research project is short enough.
- I think that the period of time over which the opportunity to contribute to this step of the research project extends is long enough
- I think I can choose the times when I collaborate and work independently to contribute to this step of the research project.

Teacher attitude towards research

- I believe that the results or learnings from my contribution to this step of the research project could be useful to me.
- I believe that my contribution to this step of the research project is not or would not be difficult or stressful.
- I think that my contribution to this step of the research project is or would be pleasant or interesting.

Teachers motivations to do research

- I believe I have the personal motivation (e.g. an interest in the subject) to contribute to this step of the research project.
- I believe I have external motivations (e.g. a reward or obligations related to my job) for contributing to this step of the research project.

QUESTION 3c - Free addition

Would you like to add anything about what facilitated or enabled (or would facilitate / enable) your contribution to this step of the research project? (free text optional)

Section 4: Recommendations for rewriting

Between late April and early May, one-day meetings will be held in various cities. Each meeting will have a specific objective derived from the analysis of the participants' proofreading notes from the first step. The overall aim of these meetings is to **provide specific advice to those who will be drafting the new version of the synthesis**. The purpose of these meetings is to reach a **collegial and justified decision on the** choices for rewriting the synthesis. Further information, including the specific objective of each meeting, the dates and the precise program, will be communicated to you shortly.

Each meeting requires the participation of different people with specific skills related to research or education, and we are sure that you have the necessary skills to take part in at least one of the three meetings. The following questions are designed to help us understand what might facilitate your participation in one of these meetings

QUESTION 4a

Would you like to be kept up to date with practical information about these meetings so that you can decide freely whether or not to take part?

- Yes
- No (finish questionnaire)

QUESTION 4b

To what extent do you agree with each of the following statements using the 7-point scale below?
The scale runs from -3 to +3 where :
-3 means "strongly disagree
-2 corresponds to "moderately disagree".
-1 corresponds to "slightly disagree".
0 corresponds to "neither agree nor disagree".
1 corresponds to "weakly agree".
2 corresponds to "moderately agree
3 corresponds to "strongly agree".

To determine whether I'll be taking part in a meeting on rewriting recommendations, it's important for me...

Self-efficacy beliefs

- ... to feel that I have the necessary skills and that I am a legitimate participant.

Context beliefs

- ... that the purpose and objectives of my participation are clear and precise
- ... choose the times when I collaborate and when I work independently.
- ... institutional support (e.g. recognition by management, remuneration or time off)

Teacher attitude towards research

- ... that the results of the meeting or what I learn during my participation will be useful to me.
- ... that my participation is not difficult or stressful
- ... whether my participation is pleasant or interesting

Teachers motivations to do research

- ... to be reimbursed for my participation
- ... that my participation will be useful to other teachers and/or researchers
- ... to play a central role in improving the next version of the synthesis.

QUESTION 4c - Free addition

Would you like to add anything that would make it easier for you to take part in this work? (free text optional)

Section 5: Conclusion

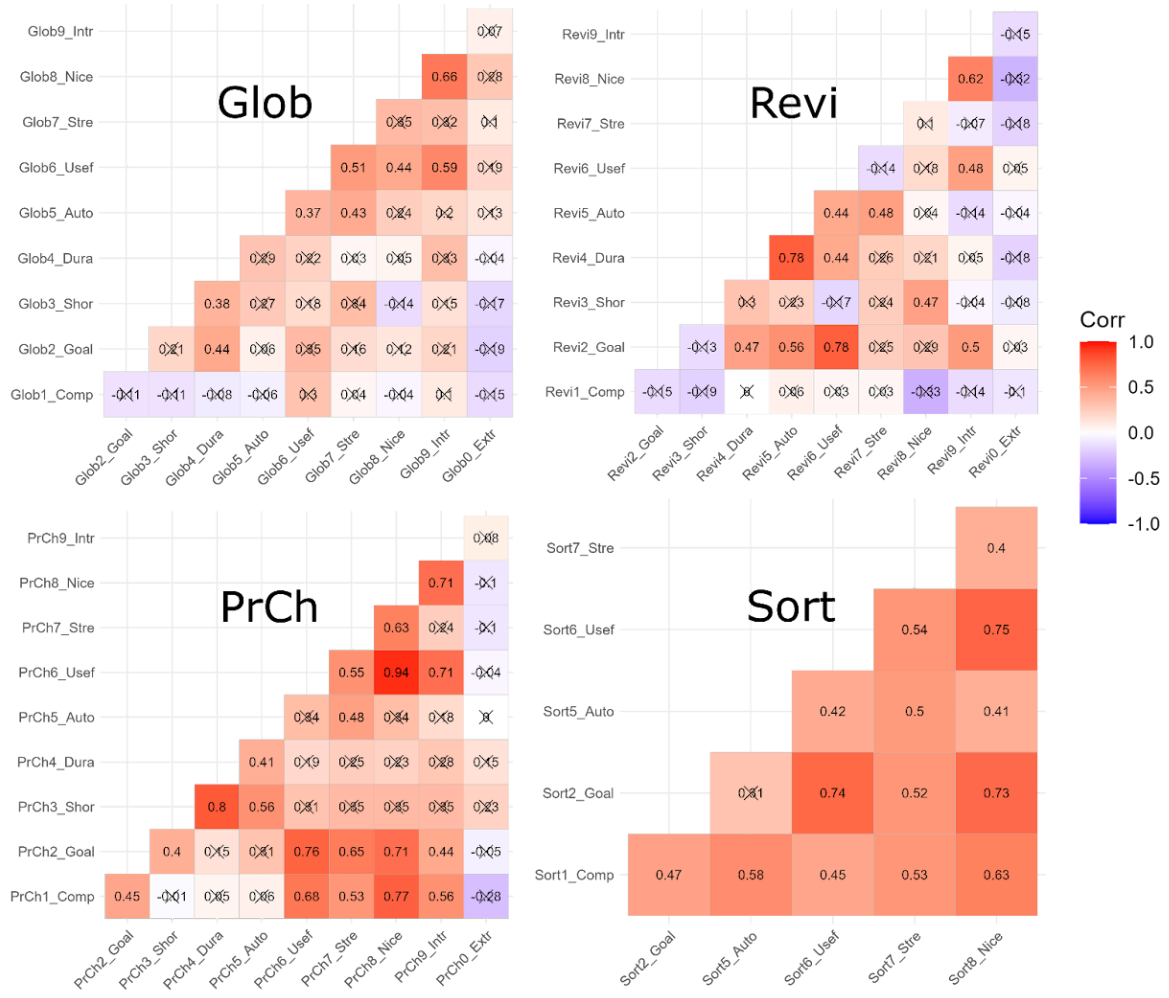
Thanks for your answers!

If you have any comments or questions, please contact nathanael.jeune@cri-paris.org.

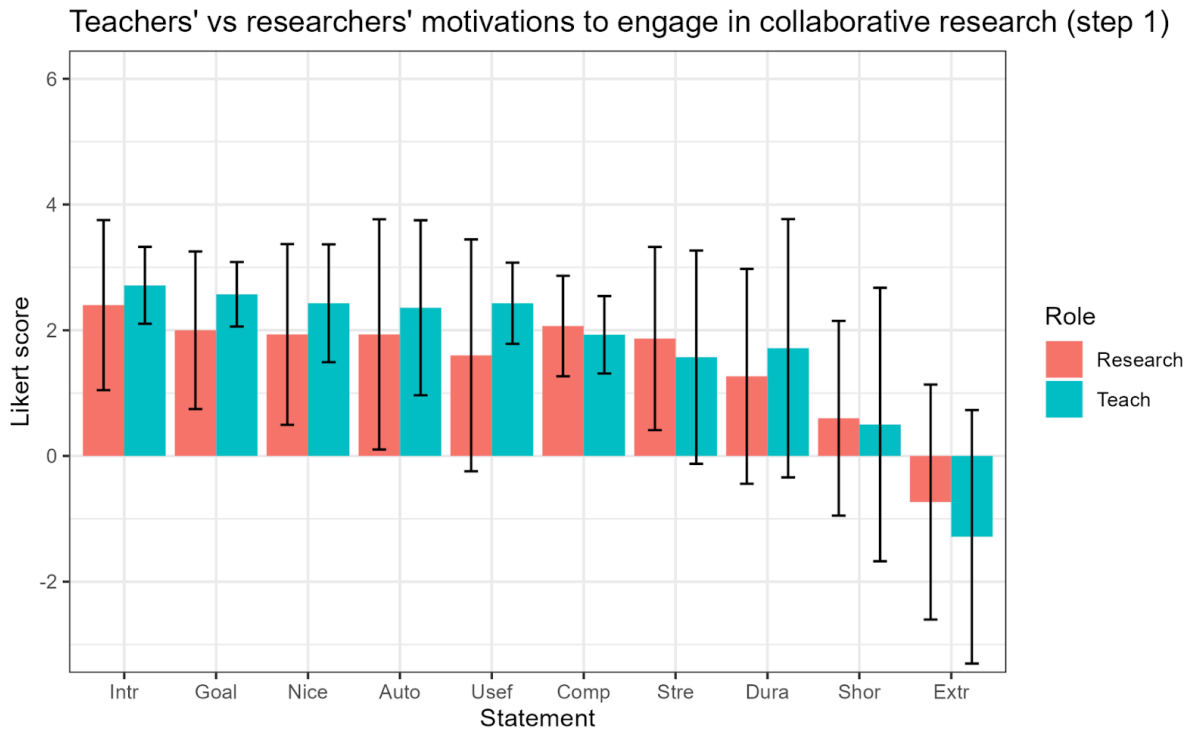
Appendix 8 - R code and dataset

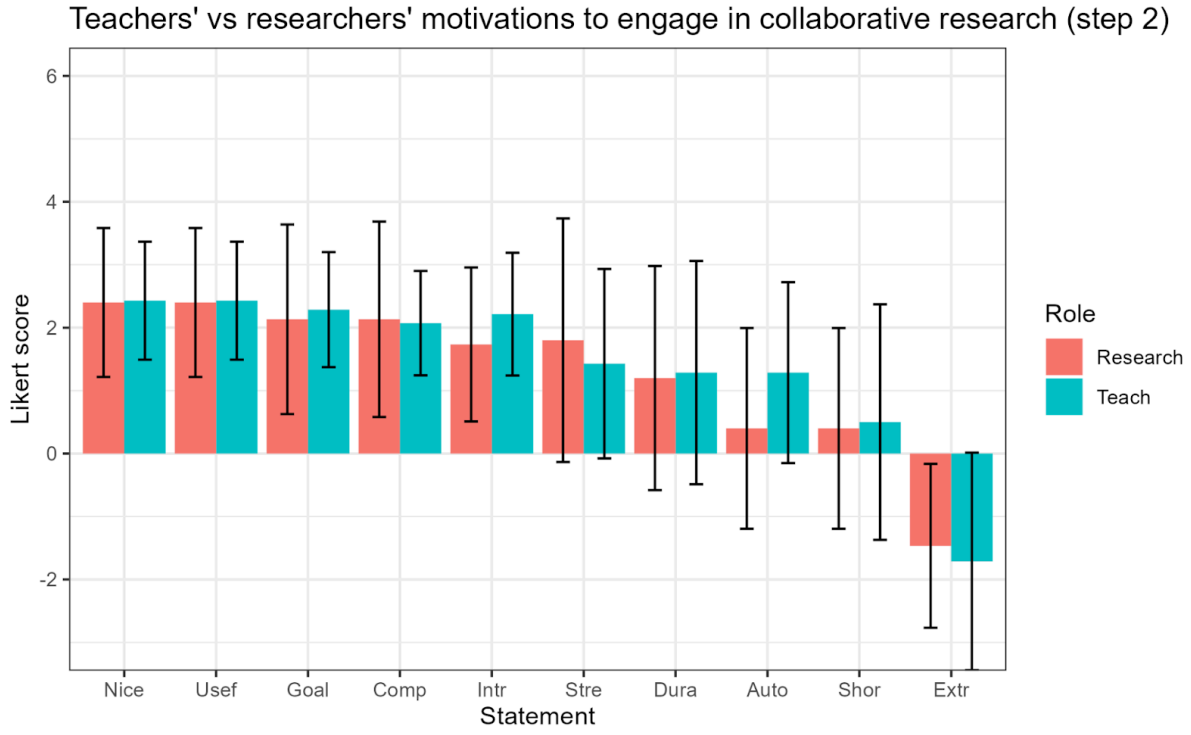
Rmd code file and pseudonymised data are available on OSF :
https://osf.io/87wnp/?view_only=91af8cee073c4f079deb33ae02e749bd

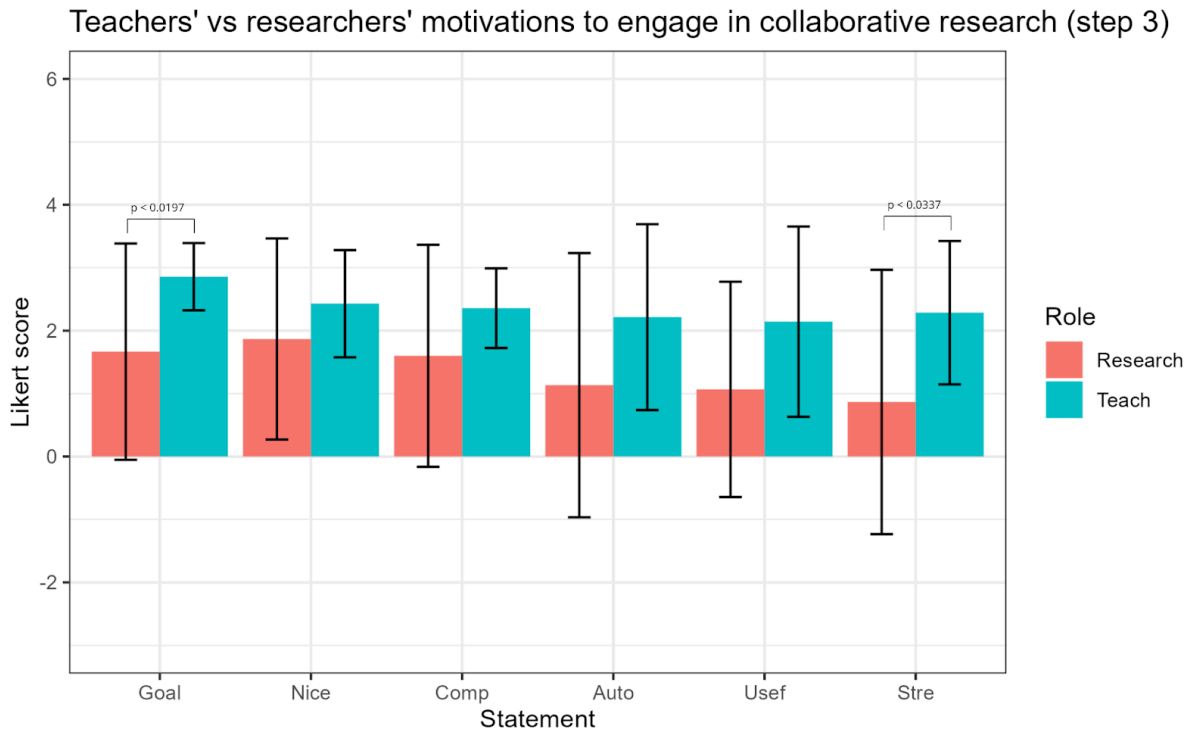
Appendix 9 - Section-based correlation matrices



Appendix 10 - Histograms with Role






Teachers' vs researchers' motivations to engage in collaborative research (step 3)
Likert score
6
4
2
0
-2
p < 0.0197
p < 0.0337
Goal
Nice
Comp
Auto
Usef
Stre
Statement
Role
Research
Teach

Appendix 11 - Side by side first component of all four sections

	Weight of each item in the first component of each section			
Names	First section (in general)	Second section (step 1)	Third section (step 2)	Fourth section (step 3)
1_Comp	0.064	-0.14	0.697	0.774
2_Goal	0.451	0.846	0.797	0.82
3_Shor	0.387	0.248	0.56	NA
4_Dura	0.485	0.766	0.434	NA
5_Auto	0.575	0.733	0.518	0.661
6_Usef	0.814	0.717	0.906	0.846
7_Stre	0.667	0.363	0.74	0.732
8_Nice	0.637	0.528	0.931	0.849
9_Intr	0.761	0.49	0.719	NA
0_Extr	0.167	-0.19	-0.05	NA

Appendix 12 - Research-brokered resource on teaching critical thinking (english version)

Teaching critical approaches

A resource drawn from research to help teachers foster pupils' ability to engage in critical approaches across different contexts

A resource by the ÉPhiScience *association, with support from* Universcience - l'école de la médiation, Université Paris Cité *and* Profs-Chercheurs (Learning Planet Institute).

Author : Pleen le Jeune

With the help of: Christophe Adourian, Ignacio Atal, François Audigier, Virginie Bagneux, Charlotte Barbier, Juliette Benelli, Sabine Bosler, Aline Bousquet, Antonin Broi, Elodie Callis, Jérôme Charlon, Marc-André Ethier, Mathieu Gagnon, Nicolas Gaube, Philippe Hubert, Stéphanie Huc, Laurence Janin, Camille Lakhlifi, Maryline Lakhlifi, Arnaud Longueville, Adeline Lucchesi, Céline Montet, Nicolas Petit, Maxime Quentin, Karine Ramon, Charlie Renard, Gilles Sahut, Céline Schöpfer, Nathan Teysseron, Véronique Winand.

Based on a document by: Charlotte Barbier, Audrey Bedel, Kévin De Checchi, Nathanael Jeune, Camille Lakhlifi, Gwen Pallares, Nathan Teysseron

Illustrations, diagrams, visual summaries and graphical elements: Guillaume Monnain - @akenium

How can I cite this document?
Jeune, N. (2024). Éduquer aux approches critiques (ÉPhiScience, Éd.). https://ephiscience.org/esprit-critique

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Introduction

Teaching critical thinking : nuancing the self-evident.

Most seem to agree that teaching critical thinking is important, and that young people need to develop their critical faculties in order to become responsible citizens. But this apparent consensus belies what are in fact varied worldviews : should one be critical at all times? About everything? Is critical thinking rooted in doubt, or in trust? And on what basis should such trust be granted?

We will not be offering a definitive answer to these questions and encourage you instead to keep in mind the rich and legitimate uncertainty as to the very notion of critical thinking, as "the avoidance of polysemy is one of the characteristics of totalitarianism." (Jehel & Saemmer, 2017, p. 77).

Nevertheless, in this resource we wish to help every teacher to find practical answers to their own questions about teaching critical thinking, while maintaining a critical approach to the very notion of critical thinking education. For this purpose, we have drawn from the diverse expertise of more than 25 teachers and researchers in various fields to create this resource via a collaborative process.

In the meantime, we invite you to broadly place your trust in us as you read, and to endeavour to reflect as much on those points of agreement you have with what you read as one those places you might find issue with. We have produced a note-taking guide to help teachers make use of scientific research (FR) within the Teachers as Researchers program. Consider joining the Teachers as Researchers community devoted to critical thinking education (FR) to take advantage of it!

Why rely on scientific research when developing a resource for teaching critical thinking?

Relations between academic researchers in education and school practitioners are complex and come up against a number of paradoxes. For instance, certain teachers express their need for educational practices substantiated by the results of scientific research and are sometimes disappointed by the gap between such research and its often difficult implementation in a classroom environment. Others worry about institutional impositions, or about researchers constraining their freedom in choosing a teaching approach or asking too much of their time, even when they might otherwise appreciate certain scientific studies.

Research focusing on the determinants of use of academic research by teachers (for instance Dagenais et al., 2012) illustrate the many hurdles to such adoption. It thus appeared essential to us to develop resources through joint deliberation with researchers and teachers in order to incorporate all expertises. This document is intended to continue to evolve along with the emergence of new research, whether they come from teachers or researchers, ideally from both, or with changes to the institutional context.

How to best use this resource

Developing new ideas about the way the world works is innate; changing existing conceptual frameworks, less so (Clough, 2006). With that in mind, it seems preferable to us to try to prevent the creation of misconceptions rather than attempting to modify them after the fact. This applies as much to one's own ideas (what is critical thinking? how to best develop it?) as those of pupils. That is why we have, for each section, suggested alternatives to approaches that may be appealing, but risk creating misconceptions.

Changing one's views, ideas or practices is costly. Though much work went into developing this resource in order to ease any such changes, it may require motivation, time and effort from you too. Thus we invite you to honestly ponder the question: what need or desire on your part would justify such a commitment?

The two types of need this resource could meet

To begin with, let us stress that we believe that critical thinking has a place in every subject and at every stage, from nursery school to higher education, unlike France's Centre for Media and Information Literacy (CLEMI) for instance, which has framed school librarians as the 'main executors' of media literacy education (Education aux Médias et à l'Information in France) (Bosler, 2023). We feel that cooperation between the various actors of the education community is essential to encompass the wide range of approaches to critical thinking education that we are about to present.

The first need this resource might meet is that of teachers who do not have a strong a priori conception of critical thinking education or who wish to challenge a vision of critical thinking education that they find unsatisfactory. You will find herein a firmly justified enunciation of the concepts which allow one to outline what critical thinking is in a practical sense,

suitable for the classroom. Far from preconceived notions about research that is out of touch with real world conditions, each conceptual element is designed to facilitate satisfying teaching practice that is helpful to pupils.

The second need this resource might meet is that of teachers whose conception of critical thinking is broadly aligned with the research presented here. We suggest avenues of teaching practice consistent with current research and encourage you to observe certain elements and to determine the effect of these practices in your own context. By joining the Teachers as Researchers collective (FR) you will be supported in leading research which will in turn help other teachers choose promising teaching practices for their circumstances.

However, we do not feel that we provide enough information to make connections with all curricula and with all subjects. Nor do we believe that reading this document alone will be enough to bring about a profound transformation of your teaching practices or your pedagogical stance. We therefore invite you to contact us at bureau@ephiscience.org if you would like support or training as part of your professional development relating to this resource.

How this resource is structured

We have split the following content into five sections.

The first serves primarily to clarify what is meant by critical thinking, here more specifically "critical approaches", and to explain the value of thinking this concept in a way that sidesteps common conceptions of critical thinking. This first section will provide a glimpse into the following four sections, each corresponding to an important axis of our characterisation of critical approaches.

In section two, you will find several reflections about our relationship to knowledge: whether as teachers for education-related knowledge, to critical thinking, or about pupils' relationship to knowledge.

The third section on metacognition and reflectivity utilises two layers of interpretation in a manner typical of synthesis. In this part, we reflect on our own thoughts and on how to encourage pupils to engage in this same work of observing and regulating their thoughts, with an eye to developing greater intellectual humility.

The fourth section considers a subject that lends itself particularly well to student activities: argumentation, in particular dialogic and collaborative forms of argumentation about complex topics such as socioscientific issues.

Section five deals with media literacy, which of course as a discipline is often linked to critical thinking education, but here is also a pretext for tackling the topic of information research and evaluation.

We conclude in the sixth and final section by drawing links between the four preceding parts, clearly stating some of the major challenges facing critical thinking education. Of particular note are the difficulties of engaging in critical approaches across different contexts and the conditions conducive to such engagement.

Each section is itself made up of different elements:

An "in summary" box that aims to outline the content of the section to help you retain more information on your first read through, or to help you find key points on subsequent reviews.

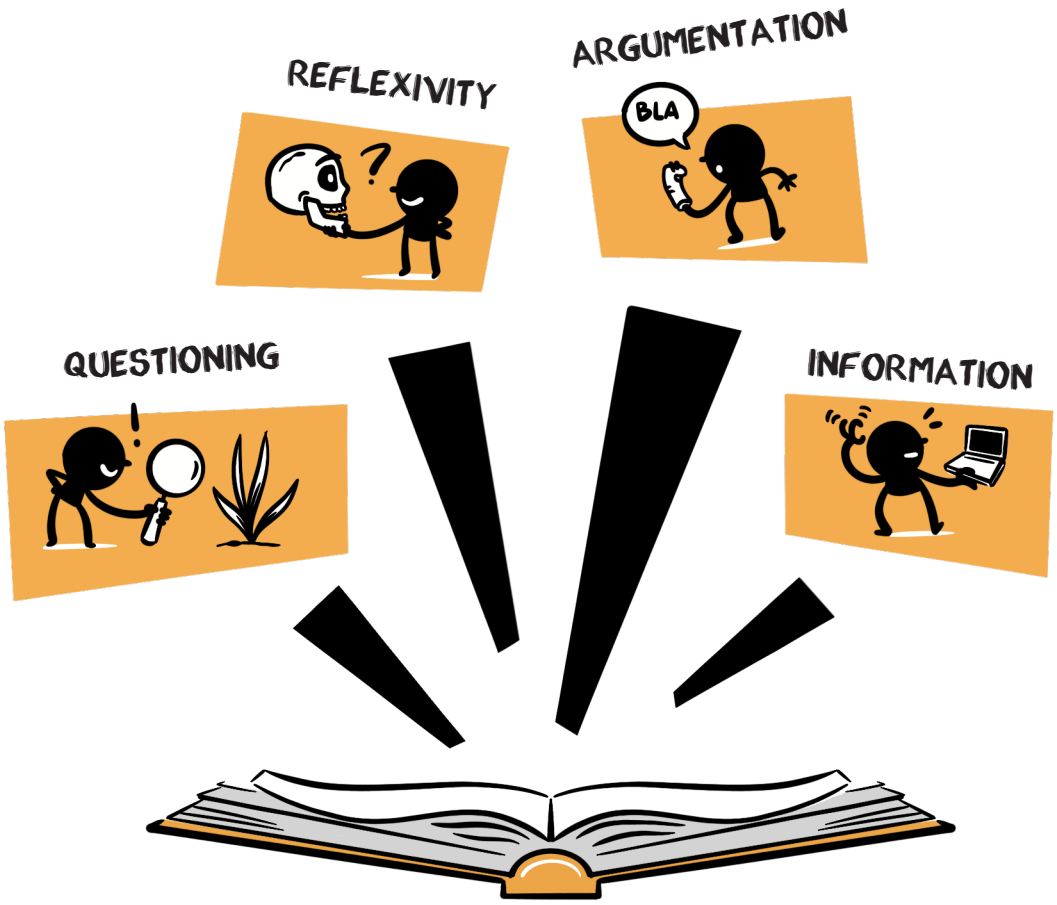
The definition of certain subjects (also available in the glossary at the end of the document), each concept being marked with an asterisk *.

The main content, inspired by research directly cited within the text, with full references provided in the bibliography at the end of this document.

"Practical example" inserts which outline a teaching challenge as well as a potential course of action to reach a desired objective, in a way that is consistent with the research highlighted in this resource.

At the end of each section, a "questions for further exploration" box allows readers to question their own ideas, educational stance or interpretation of the subject.

Definitions. Teaching critical approaches



IN SUMMARY

- Referring to critical approaches rather than critical thinking centres the situation within which the critical approach is called upon, strikes a conceptual balance between theory and action, and allows us to consider the critical approach of a group rather than an individual.
- The characteristics of a critical approach include harnessing a body of knowledge, skills and dispositions, taking context and consequences into account as well as a range of norms and standards related to what ought to be believed or done.
- Critical approaches in the strict sense include a consideration of group interests that may run counter to the individual interests of the one adopting a critical approach and may therefore overlap with self-critical and self-corrective approaches.
- The development of dispositions, skills and knowledge related to engaging in critical approaches in the strict sense is resource-intensive. Collaboration among teaching staff may enable more of the elements within the following four chapters to be covered.

Critical thinking or critical approaches?

There are many ways to define critical thinking (*esprit critique* or *pensée critique* in French). One's way of considering critical thinking will largely determine the type of teaching interventions implemented in order to develop it, given that one's pedagogical goals may vary. But despite the various debates on the subject, a shared set of general ideas emerges from the scientific literature.

Eduscol, France's official information and support platform for teachers, offers the following definition on its page devoted to critical thinking education: it is "both a frame of mind [attentiveness, curiosity, autonomy, clear-headedness and humility] and a set of practices [gathering information, appraising it, distinguishing facts and interpretation, confronting and assessing interpretations]". Thinking critically would then largely come down to processing information in the right way, which remains vague. However, a number of scientific studies emphasise that critical thinking is not limited to only this. For instance, the philosopher Ennis (1991) proposes the following definition of critical thinking, which is among the most cited in the literature:

> « [Critical thinking roughly means] reasonable reflective thinking that is focused on deciding what to believe or do. » (p. 32).

This definition has been called into question, being considered too broad. Likewise, other definitions in psychology (e.g. Facione, 1990, Boisvert, 2000) notably catalogued by Bronner & Pasquinelli (2021) are too long and complex to be of practical use to teachers.

We have chosen to use the term "critical approaches" within this resource, and will detail their main characteristics and features. The three main arguments to preferring the use of "critical approaches" over "critical thinking" are as follows:

- We wish to avoid any "essentializing" of the term critical thinking as being a mode of thought that one can "have" or "not have", as if it were a muscle, a level to be reached, or a brain mechanism that one could activate. All such views are mistaken and misleading, as is the framing of the "critical thinker": engaging in a critical approach is always situational, and two people may take different approaches, both of which are equally critical.
- Critical thinking refers to an individual and internal phenomenon, one that is invisible and difficult to access. A critical *approach*, on the other

hand, is a process a group can engage in, shifting the focus away from the individual.

- What's more, critical approaches find a satisfactory middle ground between the questions of what to believe and what to do: we are at once observing a process and its expression, thus it is both a matter of thought and of practice. In our view, this is preferable to the idea of critical thinking, which places less emphasis on action.

We also prefer to avoid the term "process" which can suggest linearity, a series of steps to be followed. The term "judgement" also seems best avoided for its negative connotations, for instance in Québec, and shares some of the drawbacks we identified with "thinking". We also think that "praxis", while halfway between theory and action, seems less adapted than "approaches" given that it is not a common part of teachers' vocabulary.

Furthermore, media literacy education and other similar "educations" (for citizenship or for sustainable development, for instance) share certain characteristics with critical approaches education:

- it is not a discipline/subject as such, but a transdisciplinary education, though it also relies on specific subject knowledge (Barthes, Lange and Tutiaux-Guillon, 2017 ; Audigier, 2012);
- it is connected to societal issues (Barthes and Alpe, 2018);
- it aims to encourage learners to adopt sound practices. It is thus tied to particular values and has a normative dimension* (see Barthes and Alpe, 2018).

***NORM:**

Set of criteria (not necessarily explicit) that are meant to be shared, relating to what is judged as good or desirable.

Although they overlap in certain respects, critical approaches education and media literacy education are not synonyms. Getting pupils to adopt dispositions conducive to argumentation is more specific to critical approaches education, while getting them to produce informational videos would not be direction relevant to critical approaches education. Though a large number of activities across disciplines can lend itself to developing pupils' abilities to engage in critical approaches, defining these is crucial to giving priority to coherent and complementary teaching strategies.

What are the characteristics of critical approaches?

As with many studies' framing of critical thinking, critical approaches require a body of 1) cognitive skills* themselves requiring 2) the harnessing of knowledge and 3) dispositions* to put these skills into practice (Boisvert, 1999 ; D'Angelo, 1971; Ennis, 1996; Lipman, 1988). The literature abounds with definitions of knowledge, skill or dispositions, but there is no consensus on these definitions either.

***SKILLS:**

We can see them as know-how for complex situations, requiring dispositions to put the skill into practice by relying on a range of knowledge or other internal and external resources (drawn from Gagnon, 2008).

***DISPOSITIONS :**

See Glossary.
Related to the concepts of virtues, attitudes or stances, or even of habitus, they refer to a recurring way of acting when confronted to a family of similar situations (Lange, 2014).

Here are some examples of knowledge, skills and dispositions that may help with employing critical approaches:

Knowledge	Skill	Disposition
Knowing what an argument, a fact and an opinion are	Forming valid arguments	Openness to diverse viewpoints
Knowing of the main causes of climate change	Assessing the credibility of a source of information	Intellectual humility

Knowledge, skills and dispositions are not all of equal relevance. For instance, knowledge about climate change is akin to "subject" knowledge (and is thus useful for engaging in a critical approach on a specific topic), whereas knowledge about what an argument is more closely aligns with declarative or theoretical "metaknowledge" (Gagnon, 2014), i.e. knowledge about that which we are trying to observe (which is thus useful for engaging in a critical approach on a range of subjects).

In the context of a discussion on climate change, engaging in a critical approach requires knowing how to assess the quality of arguments on the topic. Alongside the two aforementioned types of knowledge, a critical approach will require proficient skills in determining the soundness of arguments (according to

given criteria). Engaging in a critical approach requires being disposed to take different aspects of a situation into account (e.g. social, environmental, health, economic, etc.)

In these circumstances, a person with knowledge and debating skills but showing no critical disposition may eventually argue in bad faith, for instance by refusing to take counter-arguments into account or by seeking to save face above all else.

Given the difficulty of assessing dispositions whose expression is context-sensitive, the teaching interventions recorded in academic studies tend to focus on developing skills (Abrami et al., 2015; Puig et al., 2019). However, we believe it is essential to cultivate dispositions and not just skills.

Alongside critical approaches' joint harnessing of dispositions, skills and knowledge, they also strongly depend on context as demonstrated by Gagnon (2008), all the more so for engagement in such approaches across different contexts*. For instance, lack of time can hinder one from engaging in a critical approach. Consider a situation in which a company makes you a tantalising offer, but lack of time prevents you from checking if this offer is in line with your convictions.

***MOBILISATION ACROSS DIFFERENT CONTEXTS :**

See Glossary.
We favour this concept over that of "transfer", in line with researchers such as Gagnon (2008).

In addition to this contextual dimension, there is also consideration of the consequences of any decision about what to do in a given situation. This reflection about the consideration of consequences is characteristic of critical approaches. For example, choosing a restaurant for dinner tonight has fairly limited consequences, while Stanislav Petrov's decision to favour the scenario of a system malfunction rather than that of an attack by the United States of America against the Soviet Union on 26 September 1983 may have avoided a 3rd World War.

Even when considering what to believe, we can question the consequences of the belief, as the opposition between theory and action is reductive (Albero, 2019). Believing that women are inferior to men leads to particularly drastic negative consequences, while the belief that the final scene of a recent movie was shot near your house is inconsequential - whether you are correct in your belief or not. In both cases, prior reflection on the context (do I need to engage

in a critical approach) or the consequences (what consequences would there be to engaging in a critical approach or not) can help one determine to what extent it is appropriate to use a critical approach, especially when such an approach can be costly (in time, energy, etc).

However, it is often difficult to evaluate to what degree a person considered any potential consequences before acting or deciding what to believe. A range of discursive scenarios (e.g. discussions in the classroom) lend themselves especially well to making explicit elements of context and consequences that have been considered. We can for instance conduct anonymous surveys of the beliefs of pupils on a topic, then about their appraisal of an issue, and finally about their assessment of their own level of knowledge about the topic. This can lead to discussions on whether and when there is a need to engage in a critical approach.

Furthermore, in our previous climate change example, the school context can allow pupils to take the time to gather information and discuss it in a favourable environment. Conversely, a family chat at Christmas may not be the appropriate context for a discussion of the pollution emitted by the flights and car journeys that brought everyone together. In that situation, a probable consequence would be to bring down the mood without necessarily changing anyone's behaviours.

A further characteristic of critical approaches is their normative dimension, which can take the form of a shared set of standards on what constitutes a good critical approach, and thus one that is regarded as worth engaging in. Referring to a good critical approach implicitly relies on some values, while norms are based on some criteria (e.g.: each claim should be supported by justifications) (Bächtold et al., 2023). Some norms are generic, while others are specific (ibid).For instance, the idea that each claim should be justified seems applicable to any situation (generic norm), whereas the idea that a good justification must rely on empirical evidence (specific norm) is not valid in all fields (it would, at any rate, be more pertinent in medicine that in philosophy).

The norms upon which we depend involve criteria particular to each of the four broad themes we are going to develop, and are not limited to epistemological dimensions (e.g. searching for the truth) but also include ethical and political aspects (what can be thought of as good or fair).

Besides the importance of justifying every claim, two other standards of critical approaches might be to take arguments expressed by others into account

when constructing one's own arguments, and finally to question the expressed claims and justifications (Bächtold et al., 2023).

As part of a discussion about climate change, we could image the following dialogue:

> A : A: In my opinion, private jets should be banned (claim) as they are extremely polluting relative to the number of people they carry (justification)
>
> B : Ah, and how would you go about banning them? (questioning the claim)
>
> A : Maybe a strict ban would be difficult to get through Parliament, but at least we could tax jet owners more (taking the argument into account and tempering the claim) and use the money to fight climate change!

Diverse ambitions for critical approaches

An interesting distinction put forward by Paul (1992) between higher- and lower-order critical thinking has to do with considering the interests of other people or groups of people. Lower-order critical thinking will be engaged in by the thinker exclusively in accordance with their own values and beliefs, while higher-order critical thinking will incorporate some degree of self-criticism. For example, acknowledging discrimination experienced by women can be done with a lower-order critical approach (e.g. I wish to have more rights – individual interest), but it can also be done with a higher-order critical approach (e.g. gender inequality affects not only women, especially minority group women, but also men. Society as a whole would greatly benefit from a reduction in these and other inequalities and oppressions).

The self-correcting dimension put forward by Lipman (2003) or Gagnon & Michaud (2021) alongside the self-critical dimension can also be integrated into practices for teaching higher-order critical approaches. The idea is that the self-critical approach assesses one's practices/ideas or those of the group, and in light of this assessment, one can then implement a change of ideas or practices, that is to say a self-correction.

Teaching higher-order critical approaches can thus constitute a highly ambitious pedagogical goal, especially in a context where each teacher has limited resources. Therefore, in the interest of fostering the development of the dispositions, skills and knowledge needed to engage in critical approaches, we

encourage teachers to collaborate. The four chapters of this resource can help you gradually take on board the avenues opened up by research for the development of pupils' ability to harness critical approaches.

How do I discuss it with my pupils?

Depending on the age of your pupils, you might first want to define critical approaches in a simplified manner, though to our knowledge there is no scientific research allowing us to ascertain whether, and how, it is desirable to adapt the definition of critical approaches according to their age.

One could define them as follows: "a critical approach is when you think very hard to try to work out whether something is true, if it is a good thing, or what you need to do in a situation. And most important of all is that you explain the reasons why you think that way."

In any case, we recommend that you make clear to your pupils what a critical approach is in your view, as well as the learning goals of your lessons. This has the advantage, on one hand, of forcing you to clarify both these objectives and your view of critical approaches to yourself, and on the other hand, it could help your pupils understand what is expected of them.

PRACTICAL EXAMPLE

Challenge name

How can I introduce the foundations of critical approaches to my pupils in a classroom environment? (FR)

QUESTIONS FOR FURTHER EXPLORATION

How would you define critical approaches, and what do you identify as the teaching goals, norms and criteria underpinning that definition?

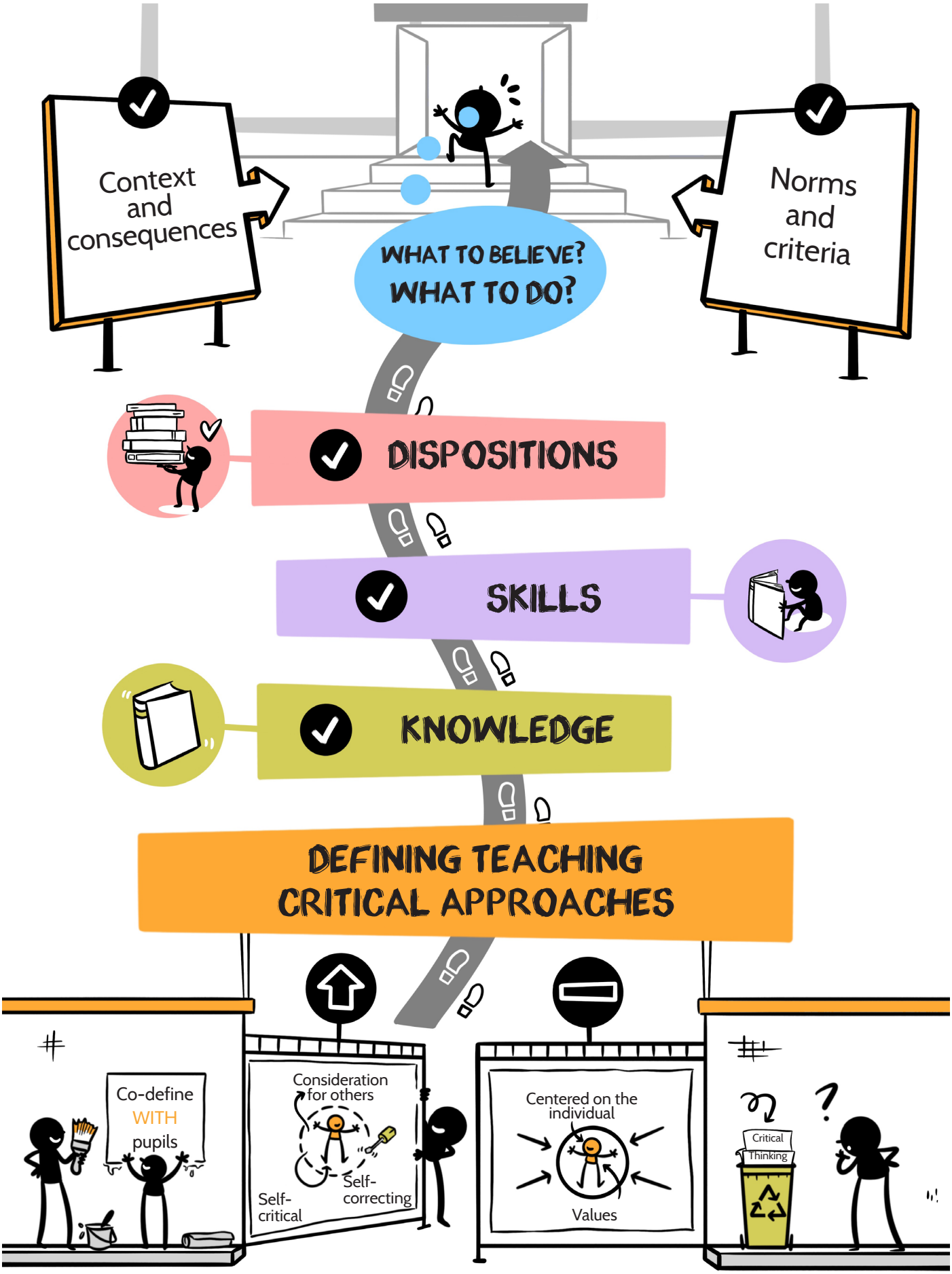
What activities pertinent to teaching critical approaches have you already implemented, and how would those relate to the points made in this resource?

What elements of the curriculum seem to tie in with teaching critical approaches?

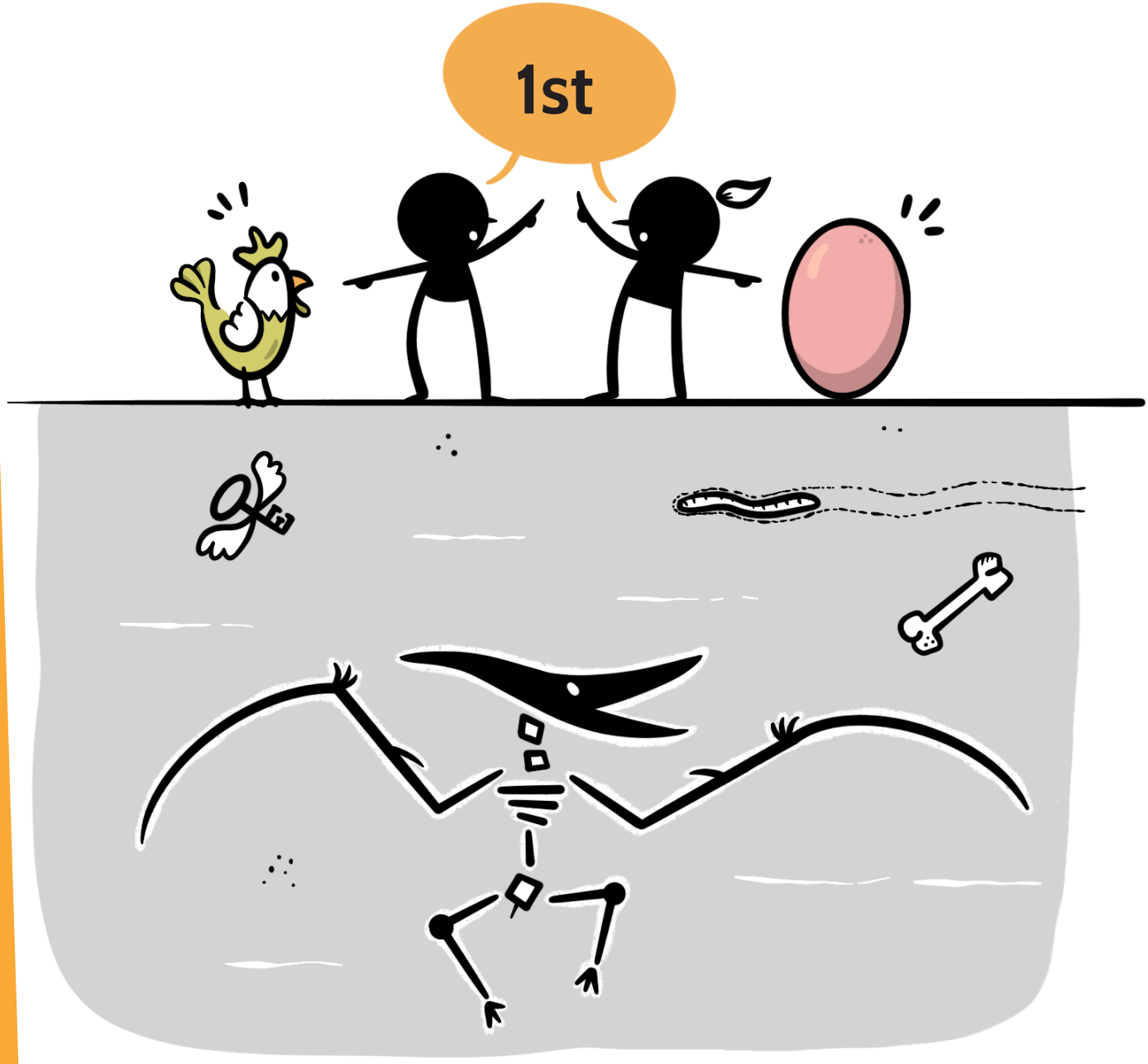
To what extent do you feel like an expert in critical approaches teaching?

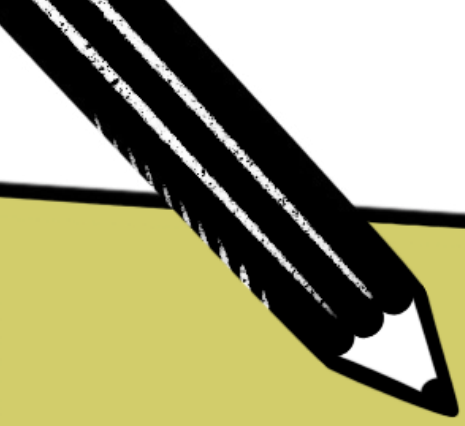
What parts of your socialisation* and personal background play a role in your perception of critical approaches teaching?

How much time would you want to dedicate to teaching critical approaches right now, and would it be realistic given your answers to the other questions?


Context and consequences
Norms and criteria
WHAT TO BELIEVE?
WHAT TO DO?
DISPOSITIONS
SKILLS
KNOWLEDGE
DEFINING TEACHING CRITICAL APPROACHES
Co-define WITH pupils
Consideration for others
Self-critical
Self-correcting
Centered on the individual
Values
Critical Thinking

Relationships to knowledge. Interrogating teacher and pupil stances

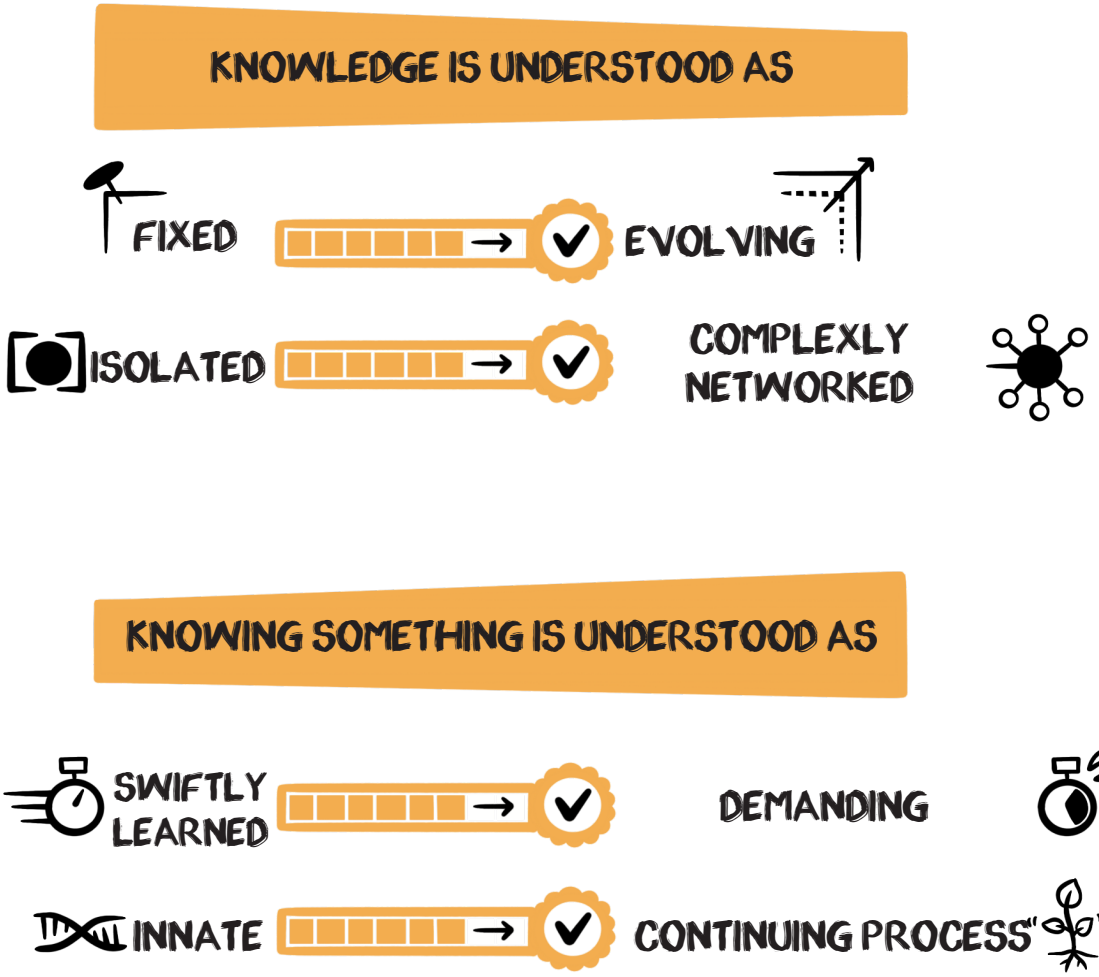




IN SUMMARY

- Our relationship to knowledge relates equally to the nature of knowledge (in particular of science) and to the act of knowing, and plays an important role when engaging in critical approaches. It is especially helpful to consider knowledge as evolving and forming complex networks.
- One cannot easily rank knowledge by its trustworthiness: from one subject to another, the relevant criteria and means of production of knowledge varies.
- Nature of Science and epistemic beliefs are conducive to discussing questions about the nature of knowledge (in particular scientific knowledge) and its production (procedures and methods), as well as about the act of knowing.
- Our relationship to knowledge can be thought of as a stance which depends on many elements of context and is not fixed, and which can thus evolve, notably relative to the subject. This stance can be identified and worked on via pupil activities that get them to express their thought process out loud.
- Though it can be difficult, questioning one's own stance as a teacher can be conducive to making pupils' relationship to knowledge evolve.
- It is useful to simultaneously work on pupils' thinking about the characteristics of knowledge they touch upon in school and the manner in which this knowledge is produced. Explicitly illustrating the differences and similarities between subjects could help students engage in critical approaches across different contexts.

Our relationship to knowledge relates, on one hand, to the **nature of knowledge** (what are the characteristics of different forms of knowledge, scientific or otherwise, in relation to the means of its production) and to the **act of knowing** (how can we know an object and what does that say about knowledge?). Gagnon (2011) describes a dual continuum of these two dimensions along which our relationship to knowledge is positioned:



Studies have shown that the tendency of pupils to understand knowledge as evolving or forming complex networks is correlated to their ability to engage in critical approaches, as well as to their perseverance and academic success (ibid).

Scientific research* produces shared, common knowledge, and thus plays an important role in helping us know what to believe, assess the trustworthiness of information along various criteria, or formulate sound arguments.

***SCIENCE:**

See Glossary
We include here a wide range of fields of academic research, not only experimental sciences but also the humanities, social sciences, history, geography, linguistics, etc.

However, our understanding of the knowledge produced by this research is often partial, and sometimes a source of misinterpretations. Learning to engage in a critical approach requires challenging one's own relationship to knowledge, including to scientific knowledge. It is therefore important to understand what pupils' preexisting relationship to knowledge is.

One example of a common teaching strategy that conveys a problematic relationship to knowledge uses an 'evidence pyramid' ordering different sources of knowledge by their a priori degree of trustworthiness. Within it, scientific consensus is placed at the top of the pyramid, followed by meta-analyses, then replicated experimental research (such as randomised controlled trials). Conversely, first-hand testimonies or personal experience are placed at the very bottom of the pyramid, being deemed unreliable. In fact, most infographics depicting this evidence pyramid contrast 'factual' evidence to 'worthless' testimonies.

This hierarchy of knowledge poses a number of problems:

- The evidence pyramid tends to present knowledge (particularly scientific knowledge) as fixed, and does not convey its organisation in complex networks.
- The very concepts of meta-analysis and experimental research are adapted to specific scientific fields, originally that of medical research (Tugwell et Knottnerus, 2015 ; Djulbegovic & Guyatt, 2017). Darwin's evolution or Einstein's relativity have now reached scientific consensus, but this is not the result of meta-analyses.
- Many fields of research only have limited scientific consensus, and one must be aware that such consensus can evolve and be challenged.
- Some meta-analyses and experimental research can be of low standard and thus be unreliable (Atal et al., 2019).
- Each method of knowledge-making has a restricted domain within which it is valid, and can only be used to answer certain types of research questions. They are fundamentally complementary and each cannot guarantee sound or pertinent knowledge on its own. It is essential to understand both the value and the limits of each method.
- In most cases, neither teachers nor pupils have the time or skills to read scientific studies, but will rather use information written by journalists or experts (a notion which itself is rarely rigorously defined/delimited and can be misleading).

- Philosophical works have often challenged and nuanced the place of science in the production of knowledge. For instance, standpoint theory (Harding, 1992) lays out an epistemological framework with a validity domain within which testimonies can have great value. For example, a person with lived experience of mental health issues will in some respects possess personal knowledge complementary to the academic knowledge of doctors (Godrie, 2017).

To develop a relationship to knowledge more adapted to critical approaches, we propose to draw from two concepts from education research: the concept of Nature of Science and that of epistemic beliefs.

Nature of Science*

Many philosophical or scientific studies have sought to understand what constitutes the specificity of the sciences. Understanding some of these specificities is important to developing a relationship to knowledge conducive to engaging in critical approaches. These include the evolving nature of scientific knowledge, which is therefore impermanent, but also the subjective and socially grounded dimension of such knowledge, which takes the form of theories (Galili, 2019). Theories are to be understood not in the popular sense of a vague idea, or hypothesis, on the workings of some object or process, but rather as a complex and coherent model from which one can make verifiable predictions.

***NATURE DES SCIENCES :**

See Glossary
This concept emerges from the philosophy of science, and refers to the characteristics of scientific knowledge. We broaden its use to also include the manner in which this knowledge is produced.

It is also important to understand that theories do not simply consist of an accumulation of observable facts: any observation or experiment is interpreted through the lens of a complex network of related knowledge and is critically appraised by peers. An identical fact can be interpreted in a variety of manners, as illustrated in teaching by the following example. Suppose we have data showing a 95% pass rate for a mathematics test at a given school. We might deduce from this that the pupils at this school are clever, or that its teaching is outstanding, or even that its expected standards for mathematics are too low (Cain et al., 2019). To take another example, getting pupils to observe cells under a microscope will likely not, by itself, allow them to understand what a cell is.

With regards to critical approaches, i**t is important in science to develop in oneself and foster in others what Hasni and his colleagues call "a stance** (a scientific spirit, according to Bachelard)" (2018, p. 25). Similarly, **it is beneficial to develop other stances suited to each subject** (e.g. historical thinking) which will facilitate engaging in critical approaches across different contexts.

For instance, the process of scientific inquiry*, which is widespread in science teaching in France and many other countries, is not immediately applicable to the study of history. While both subjects will share aspects of their approach, such as interrogation, interpretation and analysis, the nature of the documents to interpret and analyse is often quite different. A pupil having learned to engage in a critical approach in one subject can thus fail to harness it in another.

***SCIENTIFIC INQUIRY**

See Glossary
These include common elements with critical approaches such as formulating questions and problematization or analysing and interpreting data.

On the other hand, education research has not attained a consensus either on what conception of Nature of Science we should seek to convey, nor on what the best way to do so would be. **The findings of Bächtold and colleagues (2021) suggest that Nature of Science and scientific inquiry can be jointly developed**: this amounts to considering the nature of the knowledge produced by science and the methods used to produce it as inseparable. As such, we believe that reflection on the Nature of Science **should ideally take place within each subject in order to best develop a relationship to knowledge conducive to engaging in critical approaches across different contexts.**

This would also seem consistent with the sometimes very different views of critical thinking expressed in different subject fields (Gagnon & Hasni, 2020). It should be noted that these comments about Nature of Science teaching do not correspond to additions to already busy curricula but rather a lateral move to the way these topics are currently taught (Clough, 2006).

Here are some suggestions for fostering a relationship to knowledge conducive to engaging in critical approaches in all subjects (Hasni et al., 2018 ; Clough, 2006 ; Kruse, 2008):

1. Explicitly place emphasis on learning to ask pertinent questions, for example:
    - Why are we studying this problem and what are its characteristics?
    - What already understood knowledge or facts would be useful to working on this problem, and why would other knowledge or facts not be relevant in this case?
    - What research processes are involved in generating the knowledge and facts needed to tackle this problem?
    - What consequences might studying the problem in a given manner lead to, and what would the ethical and social stakes be?
    - How can we go about finding a common, reliable interpretation of the results that emerge from our problem-solving process?
2. Shift your teaching stance towards that of a facilitator, for example:
    - Support pupils' discussions and debates, which are part of the social dimension of the knowledge creation process and are essential to critical approaches. The idea here is to offer appropriate scaffolding so as to avoid the twin pitfalls of:

        - Transmission: the teacher takes over and ends up choosing a "correct interpretation" for the pupils;
        - Neglect: the teacher withdraws completely, leaving pupils to "discover on their own".

    - Model dispositions that reflect as much a critical approach as a scientific attitude, for instance intellectual humility when confronted to unexpected student questions, or demonstrating nuance and caution regarding your own understanding of various scientific methods.
3. Present a range of topics and methods, for example:
    - Do not limit yourself to a single approach (e.g. experimental method in science subjects, or document analysis in history)
    - Collaborate with other subject colleagues or researchers to make differences in the relationship to knowledge explicit, notably between multiple subjects (e.g. different methods, the nature of studied objects lending themselves to various approaches)

- Diversify your approach between explicit decontextualized teaching (based on grounded, familiar experiences to the pupils, at first glance seeming distant to the curriculum) and explicit contextualised teaching (based on research and the processes resulting in subject context, more clearly theorised/formalised) along with the entire spectrum between them.

PRACTICAL EXAMPLE

Challenge name

How can we improve pupils' conception of science? (FR)

Challenge goal

Guide pupils to better understanding the production of scientific knowledge and the status of the sciences.

Action title

Interdisciplinary activity on the various representations of planet Earth and its movements (FR)

Croyances épistémiques*

Among researchers working on epistemic beliefs, Kuhn, Cheney and Weinstock (2000) proposed a description of the progression of epistemological understanding in essentially three levels: "absolutist", "multiplist" and "evaluativist", as outlined in the following table.

***EPISTEMIC BELIEFS:**

Several concepts from parallel studies relate to beliefs individuals have on the nature of knowledge and the act of knowing. We will use the term epistemic beliefs, but for a detailed description of the different approaches, we refer you to De Checchi (2021).

	Assertions	Reality	Knowledge	Critical approaches
Absolutist	Assertions are facts that are either correct or incorrect	Reality is directly knowable	Objective: Knowledge comes from an external source and is certain	A critical approach is a vehicle for comparing assertions to reality and determining their truth or falsehood
Multiplist	Assertions are freely chosen opinions	Reality is not directly knowable	Subjective: Knowledge is generated by my mind and is uncertain	Critical approaches are irrelevant
Evaluativist	Assertions are judgements that can be evaluated and compared according to criteria of argument and evidence	Reality is not directly knowable	Including both objective and subjective facets: Knowledge is generated by human minds and is uncertain	Critical approaches are valued as promoting sound assertions and enhancing understanding

Theirs is a so-called developmental perspective, where one expects a pupil to follow a linear progression: first absolutist, then multiplist, then evaluativist - with this final epistemic belief being the desirable one for engaging in critical approaches.

This perspective is called into question by De Checchi (2021) among others, who observes that pupils can express different epistemic beliefs from one topic to another. Similarly, one can image a science teacher with an absolutist epistemic belief about their subject content (“it’s scientifically proven, so it is true”) and a multiplist belief about teaching practice knowledge (“my way of teaching is as valid as what researchers who’ve never been in my classroom might say”). And of course, a single teacher could also have evaluativist epistemic beliefs about both. **It therefore seems preferable to us to consider epistemic beliefs as “stances and structures that can take various forms and are influenced by the cultural or social context, or the person’s gender”** (De Checchi, 2021, p. 41).

A given person’s stances related to their epistemic beliefs could thus be different depending on various aspects of the context, for instance:

- Being in a school context, or an everyday one

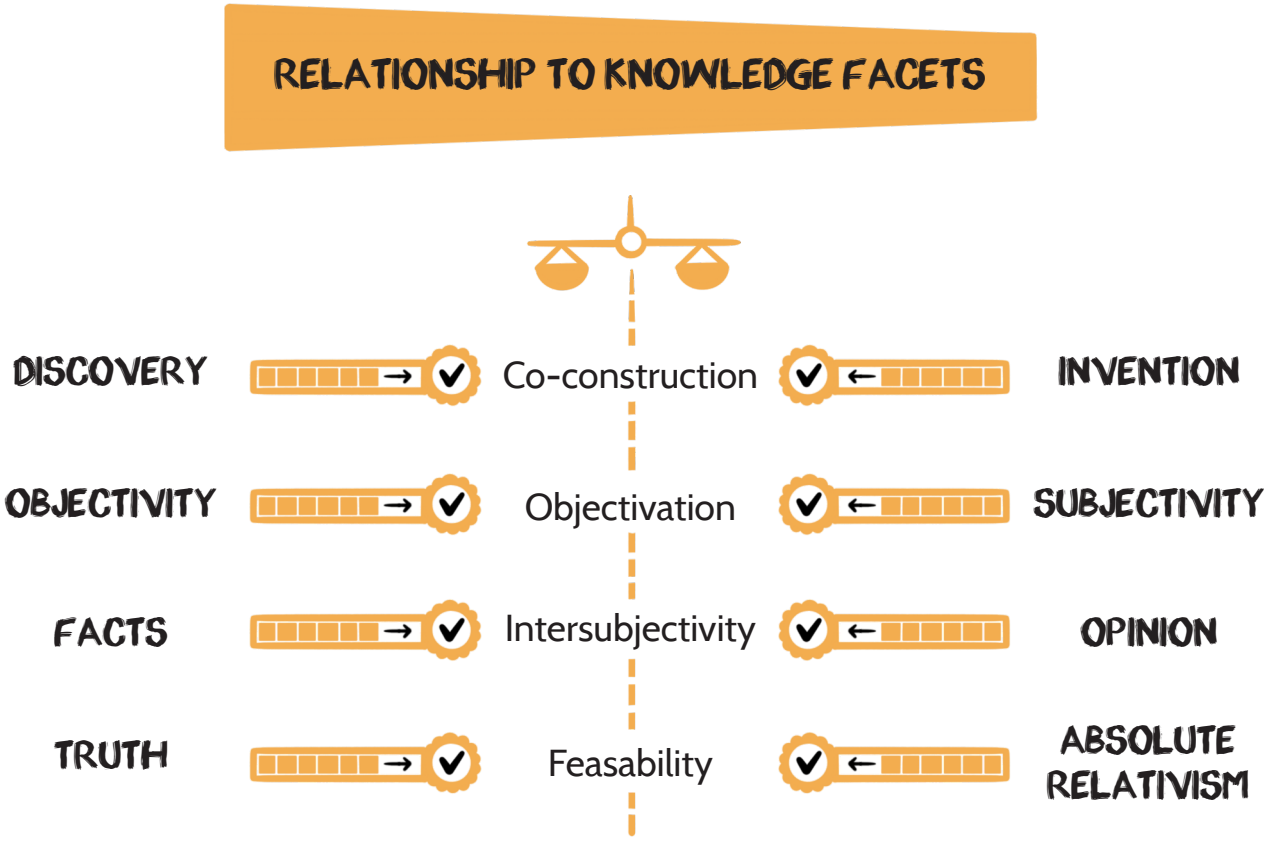
- The subject or topic at hand
- Which social interactions (only between pupils, including the teacher, etc.)

Moreover, the number of mentioned epistemic beliefs varies between researchers: a more complex model allows for finer distinctions to be made, but risks being more difficult to identify in practice. The downside of the Kuhn and colleague's model (2000) is thus also its advantage, namely its simplicity: one can envision it as a spectrum between absolutism and multiplism, with evaluativism striking a balance between the two. For absolutists, knowledge is objective and absolute, while multiplists judge it to be subjective and uncertain; evaluativist combine both beliefs.

In practice, an individual's stance will be more complex and less caricatural. For instance, we could focus on the stance that comes into play when one is assessing information. An absolutist stance may lead one to judge information as valid only if it comes from a source perceived having expertise (e.g. a distinguished scientist who asserts that a certain drug is effective as a treatment for a given sickness); a multiplist stance may lead one to judge information as valid primarily if it matches with one's personal experience (e.g. drinking certain herbal teas helped me heal from a given sickness); while a evaluativist stance may lead one to judge information as valid when there is a congruence between high-quality source and personal experiences (e.g. has the efficacy of the drug been tested in similar conditions to ones in which I have previously taken various drugs that have helped me get better in the past?).

However, this simplified three-stance representation obscures other interesting avenues we could explore. As explained by De Checchi (2021, p. 74), "one can hold an epistemic belief that is absolutist, i.e less sophisticated, but is nevertheless rich in reflexive processes, i.e processes that are turned towards external objects. For instance, among two absolutists, the first might consider that physics knowledge is indisputable and produced by scientists, while the other may base their judgement on the fact that these scientists are in possession of accurate knowledge because they use scientific methods based on criteria that ensure they avoid mistakes: falsifiability, random sampling, group comparisons using statistical tests. Both are absolutists when it comes to physics knowledge, however the latter holds an epistemic belief related to the rationale behind deeper knowledge".

Likewise, Gagnon (2020) puts forward various facets of the relationship to knowledge that are often set against each other and proposes a "happy medium" which would be conducive to engaging in critical approaches as in the following figure:



If we are to support pupils in developing epistemic beliefs - and thus a relationship to knowledge - conducive to engaging in critical approaches, a first step would be to establish a diagnosis. The following questions may provide some insight:

- How do the pupils assimilate the objective and subjective dimensions of knowledge? To what extent do they see knowledge as discovered or invented? How do they distinguish facts from opinions? Can they envision seeking a kind of soundness rather than THE truth?
- What relationship do the pupils have to uncertainty? Where relevant, how do they seek to resolve them?
- Within the classroom social context, what are the implicit and explicit norms that pupils adhere to relative to knowledge and the act of knowing?

- In your classroom, what is accepted as being fundamental to knowledge, and what is not? What about in their everyday life?
- Do the learning objectives for the various activities pupils tackle in class include an epistemic dimension? (e.g. situating one's knowledge, understanding what others think, better understanding the discussed theme, etc.)
- Under what circumstances do the pupils seem to be better able to change their point of view?

Given the complex nature of epistemic beliefs, we find De Checchi's (2021) proposal to qualitatively analyse the epistemic beliefs of pupils to be relevant. Classroom observations, written works by the pupils or interviews with them, along with any activity that leads them to "think out loud" while describing their thought process as they go, all seem promising. Provided one is well-versed in conducting them, philosophical debates and discussions in class seem to also enable pupils to harness and develop their epistemic beliefs, though this is not a given (De Checchi, 2021 ; Gagnon & Michaud, 2021). Indeed, it seems to be necessary to make the goal of developing epistemic beliefs across multiple subject areas explicit, and to give pupils the space to challenge knowledge previously applied in class.

France's science curriculum, in its assessment of experimental skills, calls for pupils to take a step back from the method followed or considered, and to take a critical approach to any results they obtain. The teaching context is thus ripe for developing pupils' relationship to scientific knowledge and it would be desirable to cultivate similar stances in other subject areas. At the French language and literature oral exam of France's Brevet and Baccalaureate, pupils are expected to provide thoughtful argumentation which demonstrates a certain relationship to knowledge they should have acquired throughout their studies. It is likely that each curriculum reveals possible avenues to develop pupils' relationship to knowledge, by way of each subject area.

QUESTIONS FOR FURTHER EXPLORATION

How do you situate your own relationship to knowledge with regards to the points raised in this section?

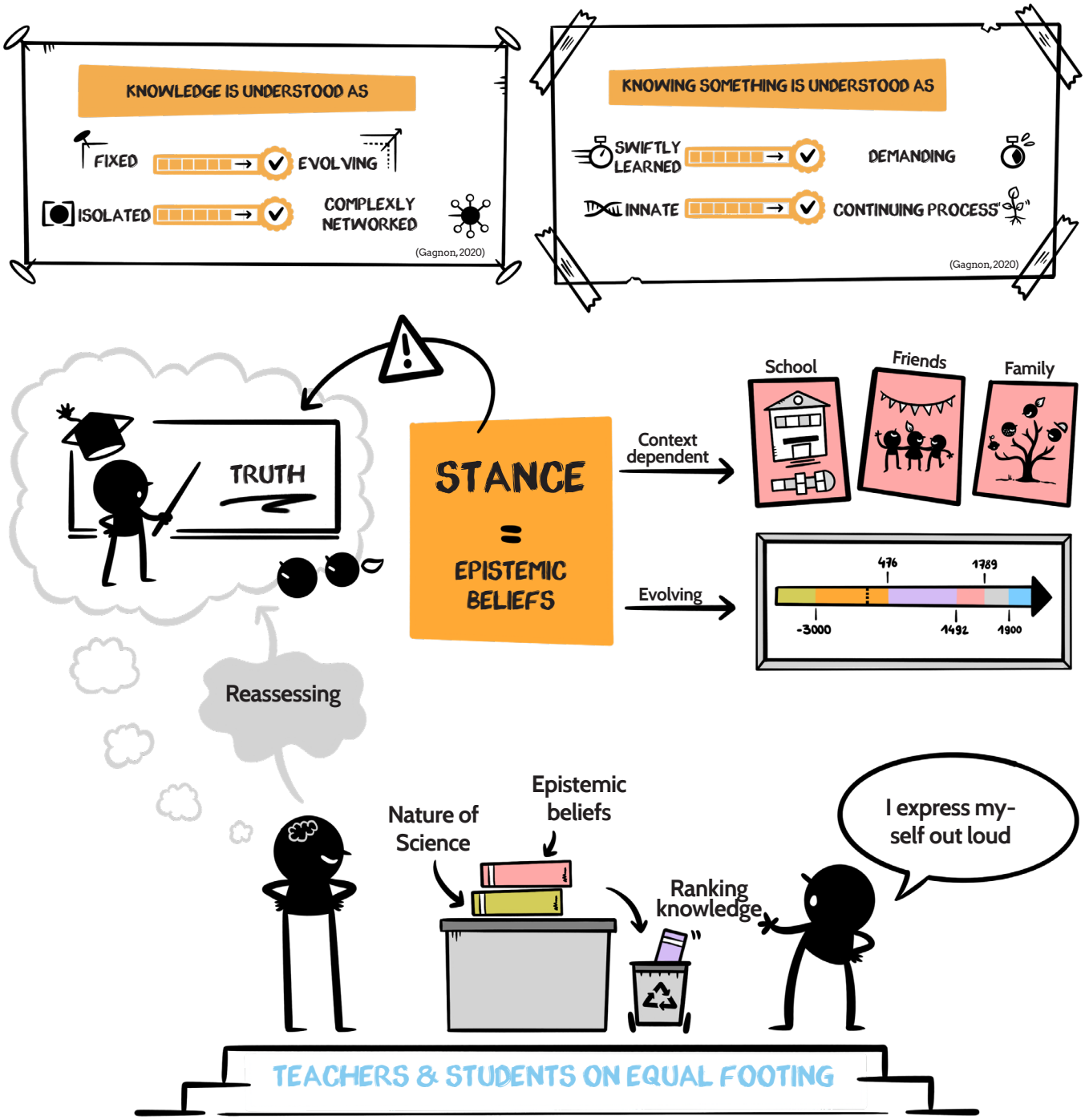
What tools do you feel you are lacking to engage in critical approaches on topics related to the subject you teach?

Are your reactions when pupils challenge the knowledge you teach conducive to developing their own relationship to knowledge?

What stances could you assume to help your pupils develop a relationship to knowledge relevant to critical approaches?

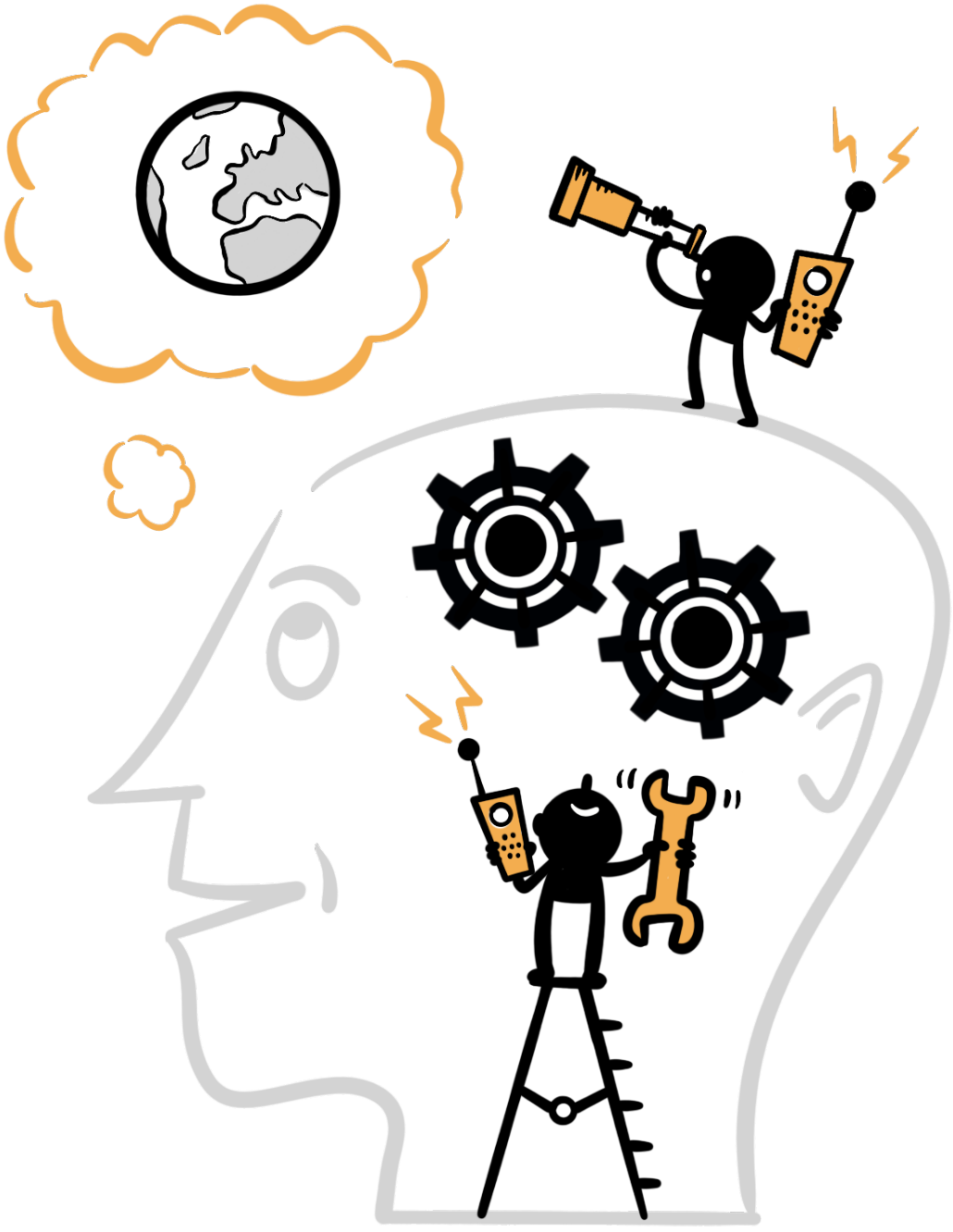
What aspects of Nature of Science or epistemic beliefs do you intend to work on in each of the subjects that you teach?

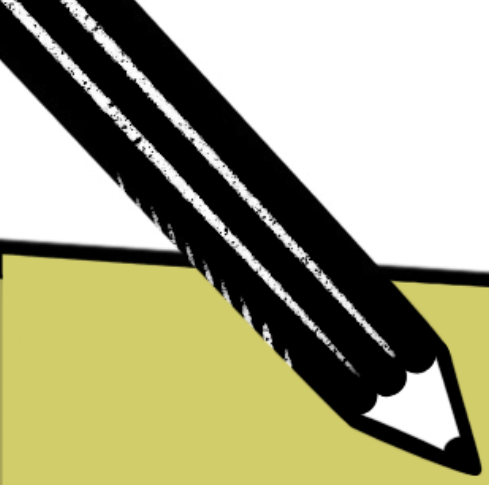
How might you collaborate with colleagues to develop pupils' relationship to knowledge in a consistent manner across different approaches and subject areas?



RELATIONSHIPS TO KNOWLEDGE

Metacognition and reflexivity. Acting on one's thoughts





IN SUMMARY

- Strategies to counter cognitive bias are time-consuming and are rarely useful in critical thinking education. We think it preferable to seek to develop pupils' metacognition, or their "thinking about one's thinking".
- Metacognition is made up of knowledge, skills and experiences whose purpose is both of oversight and of control
- It is important to make pupils want to make use of their metacognition, and it seems a promising avenue would be to create a cooperative learning environment while explicitly teaching about metacognitive strategies and their value to pupils.
- A primary objective in the development of pupils' metacognition is to teach them to inhibit less suitable strategies and not simply to teach them suitable ones.
- Assessing metacognition is complicated, but asking pupils to "think out loud" or observing particular behaviours can demonstrate pupils' metacognition.
- Employing metacognitive questioning on what one knows and one's intellectual limits can help develop intellectual humility, a useful disposition for critical approaches.
- Reflexivity is a concept that enhances metacognition with a socioeconomic , political framework that centres on others.

Cognitive biases

Critical thinking has generally been related to decision-making - "what to do" as well as "what to believe" (Ennis, 1991). Prominently used for making decisions when faced with uncertainty, the term "cognitive bias", though studied since the 70s, has been widely publicised following the release of Kahneman's 2011 book "Thinking, fast and slow". Various research strands are described in detail within the first version of a summary note available on the site of the ÉPhiScience association.

For the most part we make decisions unconsciously, or even automatically, and these decisions rely on heuristics: shortcuts in our thinking based on the information we have available. Cognitives biases correspond to systematic errors in judgement arising from reliance on our heuristics (Ellis, 2018). For instance, the availability heuristic describes our tendency to base our evaluation of the probability of an event (say a deadly plane crash) on the ease with which we can remember similar events (e.g. a recent plane crash that had extensive media coverage could thus lead to us overestimating the risk of plane travel).

Various biases have been classified (Ellis, 2018), but certain authors emphasise that in the vast majority of situations, our heuristics produce good decisions and there is thus... nothing to do (Todd & Gigerenzer, 2012). On the whole, **strategies to help people to make better decisions by mitigating their cognitive biases have not proven themselves according to research**, mainly in the medical field (Monteiro et al., 2020). While teaching "debiasing" strategies has allowed concerned audiences to remember various cognitive biases, it has not led to better decisions (ibid), with the exception of some specific cases (Dacey, 2020).

Moreover, supposedly unbiased decision-making may not fall within the scope of critical approaches, for instance when one lacks knowledge on the relevant topic. Lastly, Dacey (2020) and others suggest that it is a mistake to focus on mitigating individual cognitive biases as opposed to considering the critical approaches of a group. For example, the confirmation bias (or myside bias) that drives a person to defend a perspective that aligns with their through argumentation can be very useful. Within a well-formed group, if multiple perspectives are represented and the members of the group have good dispositions, the group's reflection will be more sound as a whole.

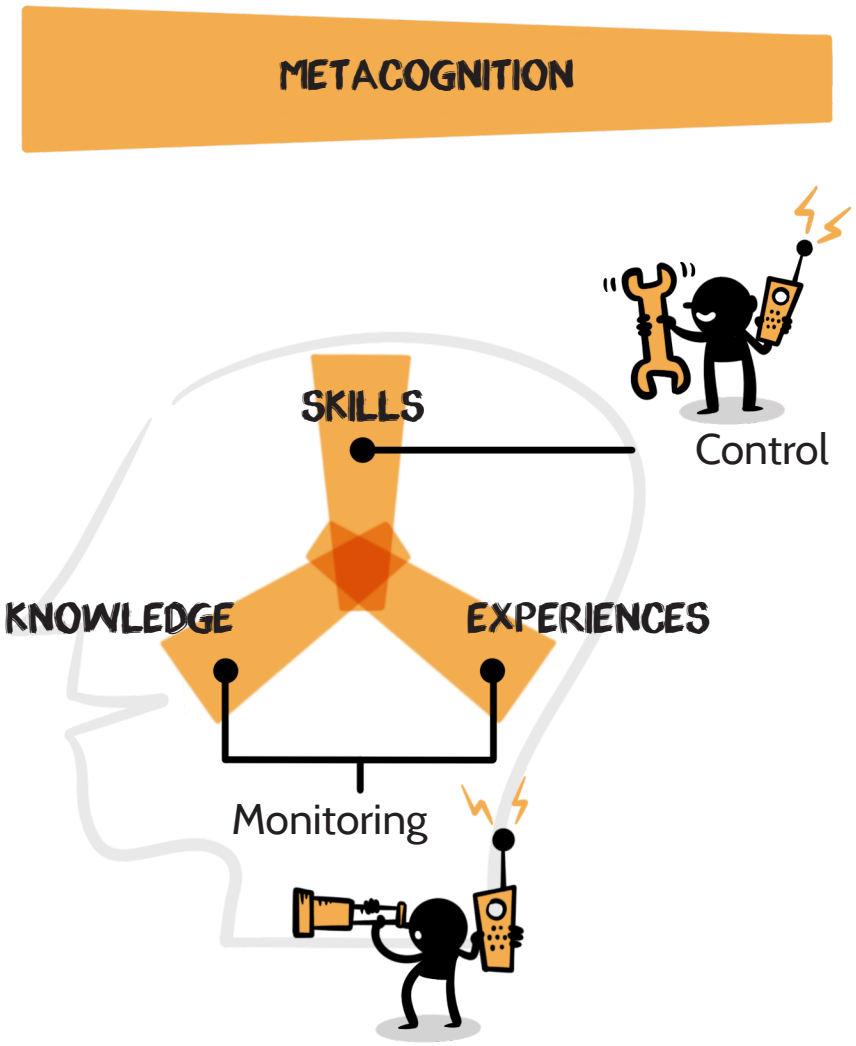
Alongside the interactionist perspective (Mercier & Sperber, 2017) which centres on dialogic argumentation, the personal development of metacognitive* strategies is a promising avenue for supporting learners in engaging in critical approaches (Dacey, 2020; Kuhn, 2022; Maynes, 2015).

***METACOGNITION:**

Metacognition is often understood as thoughts on one's thinking, or reflection about one's reflection. It is a combination of knowledge (of one's cognition and that of others), experiences (feelings and judgements related to one's cognition), and skills (strategies implemented to control one's cognitive activities).

Metacognition

Metacognition is a psychological concept studied from the 70s, with numerous developments in education (Allix et al., 2023) and sometimes related to critical approaches (Kuhn, 2022). A recent article from Allix and colleagues (2023) outlines the concept of metacognition as a combination of **metacognitive knowledge, experiences and skills. Each of these three dimensions can one hand serve to oversee (mainly knowledge and experiences), and on the other to control (mainly skills) cognition.**



Metacognitive knowledge can refer to knowledge of one's own thinking or that of others, as well as of cognition in general, and can be accessed either consciously or automatically. For instance, knowing about the effectiveness of spaced repetition for learning and knowing how to apply the strategy to learn a new language are types of interdependent metacognitive knowledge.

Metacognitive experiences can refer to anything one is aware of in relation to a cognitive activity. This includes feelings of familiarity, of difficulty, of knowledge, of confidence or of satisfaction, as well as any judgements related to the task at hand (on the information's source, or the needs, time and efforts required to accomplish the task). The emotional dimension of metacognitive experiences gives us a glimpse into other research findings: by learning to understand their own strengths and weaknesses, and by learning to use effective strategies, pupils' motivation and learning outcomes can be improved.

Metacognitive skills refer to "various strategies deliberately employed by a thinker, based upon a given goal, to control their cognitive activity during a task" (Allix et al., 2023, p. 5). Such strategies can be employed before (orientation and planning), during (verification and control), and after a task (assessing the process and result). All will rely on metacognitive knowledge and experiences, as the feeling of difficulty can trigger the need for a given strategy based on knowledge gleaned from similar prior tasks. In turn, once a metacognitive skill is brought to bear, this experience deepens one's metacognitive knowledge.

Multiple studies seem to show that these dimensions of metacognition change with age and thus partly follow a developmental trajectory, but can nonetheless be cultivated at various ages (Allix et al., 2023; Kuhn, 2022). To better understand what can be developed and when, two ideas are key: metacognition's specific or general aspects (if we learn to harness metacognition in a given context or for a specific topic, will we be able to harness it in another context or for another topic?) and the consideration of age-dependent harnessing or metacognition (must a person harnessing their metacognition do so out loud, and what to do when this is not possible?).

According to Allix et al. (2023), current understanding of metacognition is that there is **a developmental trajectory going from a specific metacognition to a more general one. This means that metacognition is domain-spe-**

cific in young children and broadens between the ages of 10 and 13 years old. Subsequently, teenagers and adults possess a general metacognition, while being able to be specific when required.

This does not mean that after the age of 13, there is no further room for improvement (Kuhn, 2022; Lai, 2011). On the contrary, developing one's metacognition requires improving the full range of general strategies to be applied in different contexts. For example, one can learn that it is helpful to ask questions such as "how can I know that..." or "to what extent can I ensure I do not make a mistake..." in a wide range of situations.

It can be difficult to recognise when it is useful to initiate a metacognitive process. It is primarily for this reason that Kuhn (2022) considers it **important to think of metacognition as a disposition first of all, more than as a skill: if one can initiate a metacognitive process but does not want to do so, then the skill itself becomes useless**. Furthermore, she asserts that such a disposition is tied to a set of values. In particular, it must be clear to the thinker that engaging in a potentially costly metacognitive process is worth it in terms of time and energy. Developing a disposition for metacognition might thus be achieved through making explicit the benefits of such a process. For instance, by giving positive feedback to pupils who verbalise their metacognition or by making them develop more effective metacognitive strategies so that they can self-regulate their learning, which would in turn have benefits for them.

Another essential characteristic of metacognition according to Kuhn (2022) is that of **inhibition: amongst all the thoughts one holds, it is important to filter out those that are not relevant to focus on. The role of metacognition is not simply to know how to choose an appropriate strategy, but more so to know how to inhibit the choice of a less effective one**, which can only be done at the cost of some effort and time.

Acquiring more effective strategies, such as memorisation and learning being easier when one makes use of a mind map or rephrases lessons in one's own words instead of simply rereading or highlighting them, does not directly lead to abandoning the less effective strategy. In the context of altering one's beliefs, which is necessary to critical approaches, the process is similar: updating one's belief system in light of new, possibly uncertain information particularly requires a fair dose of inhibition.

In order to practise toward this, Kuhn (2022) suggests a series of items to be progressively implemented in a dialogic context:

- Develop a good theory of mind* and attempt to reconcile one's own arguments and those of others, which requires sufficient inhibition to be able to distinguish between one's arguments and those of others and to identify places when they converge.

***THEORY OF MIND:**

Theory of mind is a concept developed in psychology which characterises the ability a person has to reliably envision the content of someone else's mind. Specifically, it implies the ability to understand the beliefs and viewpoint of another.

- Create a context wherein beliefs considered unimportant (for example, beliefs about the relative heights of animals) must be inhibited to provide correct answers.
- Create a context within which more and more important beliefs (for instance ones related to identity) must be inhibited in order to provide correct answers.
- Formulate assertions with which you disagree and evidence to affirm these assertions while inhibiting your own position.

Moreover, in her literature review on critical thinking related metacognition, Lai (2011) points out some promising educational approaches for the development of students' metacognition. In particular, **a teaching style blending the study of metacognitive strategies with the specific benefits of these strategies seems effective in developing a form of metacognitive reflection in pupils**. More broadly, recommendations to support the learning of metacognition seem to emerge, involving teaching it explicitly while emphasising how to use the strategies, when to use them, and why they are beneficial.

This suggestion to develop a disposition for using metacognitive strategies is especially important in Kuhn's (2022) perspective. Motivational and affective dimensions are therefore of particular importance. A promising way of considering them would be to create cooperative learning environments (Lai, 2011), that is to say environments within which pupils can engage in constructive dialogue and support each other in building a shared understanding.

But can we observe or assess pupils' harnessing of metacognition for the sake of seeing its evolution? This is a challenge shared by both researchers and teachers (Lai, 2011). Indeed, **approaches to assessment using tasks where pupils must "think out loud",** rendering a part of their thinking process visible to others, have been used extensively. For example, in a computer-based information seeking activity, we can ask pupils to explain out loud their choice of search keywords, or why they chose to refer to certain web pages over others for a given task.

Other tasks call for the pupil to judge their own metacognition, for instance by placing themselves along a scale. For example, in a debate, we can take quick surveys in which we ask pupils to rate their confidence in the truth of certain assertions.

However, these techniques seem to underestimate metacognition, notably that of younger children (Lai, 2011). Other avenues reported by the author include creating pictorial illustrations of learners' understanding and beliefs, or **observing individual or social, verbal or non-verbal behaviours which can demonstrate pupils' metacognition.**

A metacognition-related disposition to develop: intellectual humility

Metacognition is likely to play a role in the development of intellectual humility, an important disposition for engaging in critical approaches. A philosopher has recently led a review of scientific studies on intellectual humility, its definition, ways of assessing it and avenues for developing it (Ballantyne, 2023). Among the characteristic features of intellectual humility, though no consensual definition exists, we find the idea of a trait that is considered desirable involving the recognition of one's intellectual limitations and a consideration for justified divergent viewpoints (ibid).

Reflecting on the trustworthiness of one's own beliefs is needed to be intellectually humble, and mobilises some form of metacognition. **Knowing how to distinguish that which we know from that which we don't is a metacognitive ability which can therefore foster intellectual humility.**

Finally, we should emphasise the role of the teacher's stance in the development of pupils' intellectual humility: we feel that modelling intellectually humble behaviour to pupils may help them acquire a similar disposition.

PRACTICAL EXAMPLE

Challenge name

How can we help pupils to develop their intellectual humility? (FR)

Challenge goal

The desired end point is of a situation wherein each pupil develops an intellectual humility characterised by greater recognition of their broad and specific intellectual limitations, along with more and more regular acknowledgements of justified divergent opinions.

Reflexivity, a complementary concept to metacognition

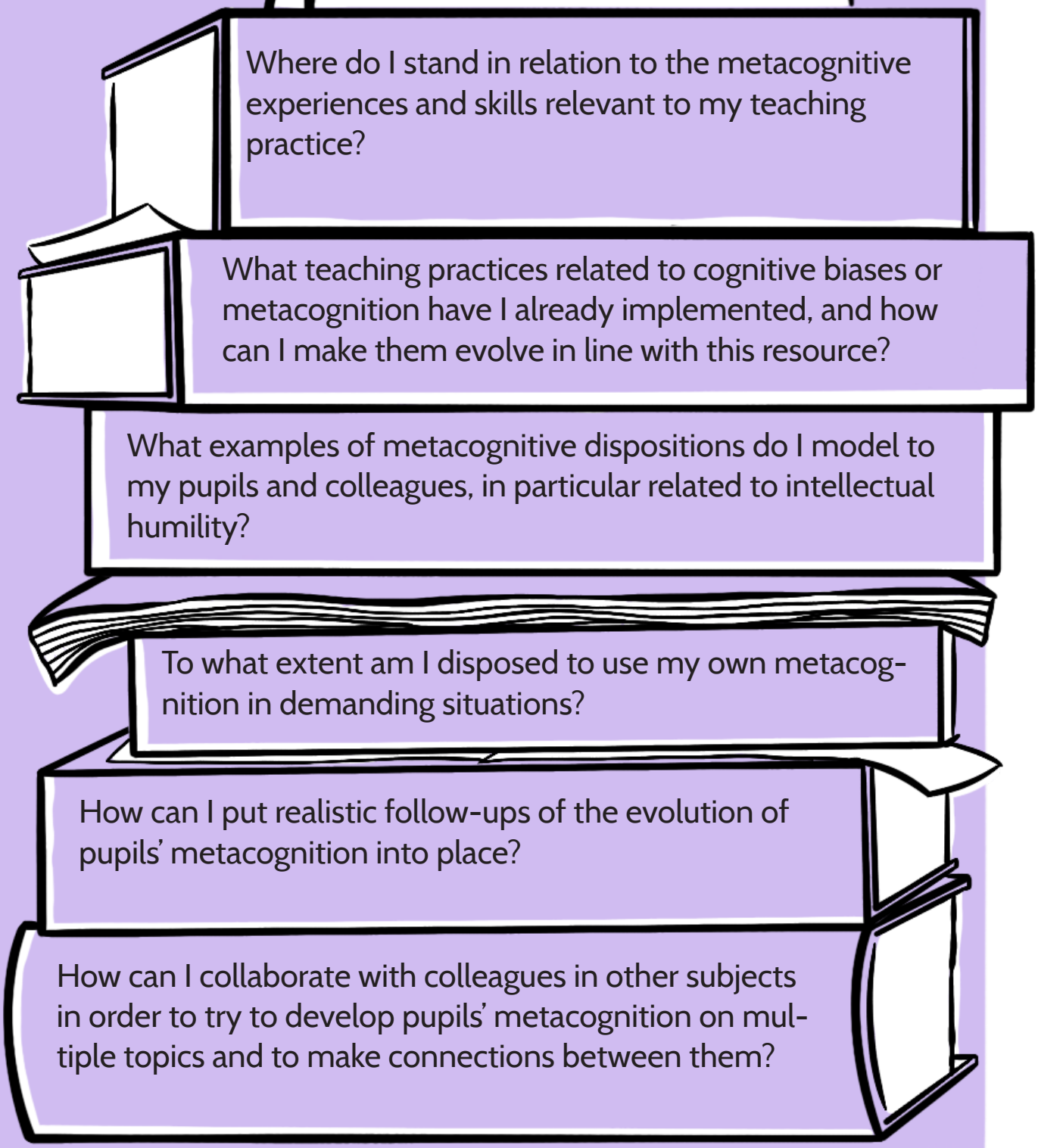
The concept of reflexivity* used in many studies in the humanities and social sciences share a number of characteristics with metacognition such as the idea of thinking about oneself, one's conceptions and one's actions. However, it goes further in attempting to place these in a socioeconomic and political context, in relation to others (Barbier & Seurrat, 2023).

***REFLEXIVITY:**

See Glossary.
Reflexivity in its complexity includes a reflection on the social conditions and influences of our reflection, not simply limited to answering "what do I think?" but also "why do I think that?"

In that respect, a pedagogical approach's consistency with metacognition and reflexivity is dependent on the nature of the cultivated questions. For example, the types of answers given to the question "why do I think what I think?" can be tackled from a cognitive angle ('because my brain works in such and such a way'), but also from a social angle ('because society influences our thoughts in such and such a manner'). We therefore feel it interesting to encourage multiple lines of metacognitive and reflective reasoning by questioning pupils about these various aspects and by expliciting the differences between them.

QUESTIONS FOR FURTHER EXPLORATION



Where do I stand in relation to the metacognitive experiences and skills relevant to my teaching practice?

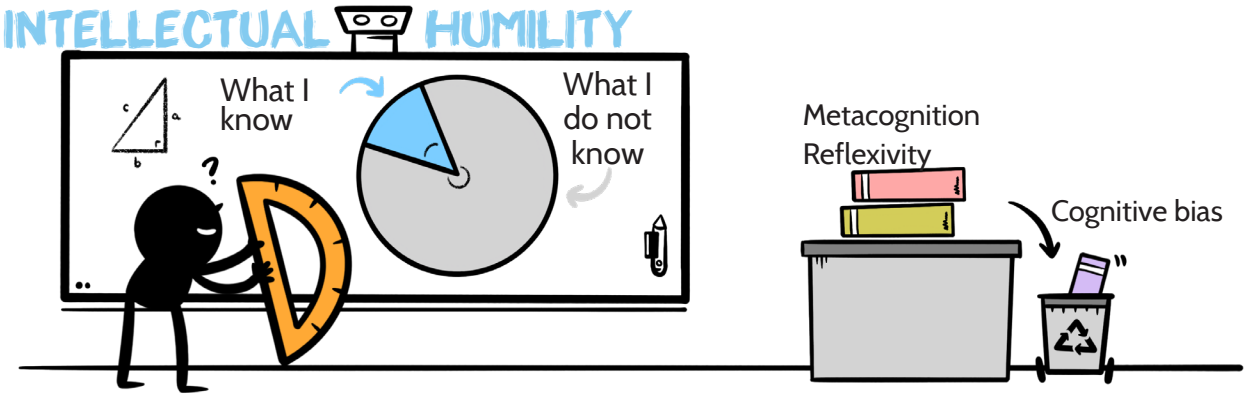
What teaching practices related to cognitive biases or metacognition have I already implemented, and how can I make them evolve in line with this resource?

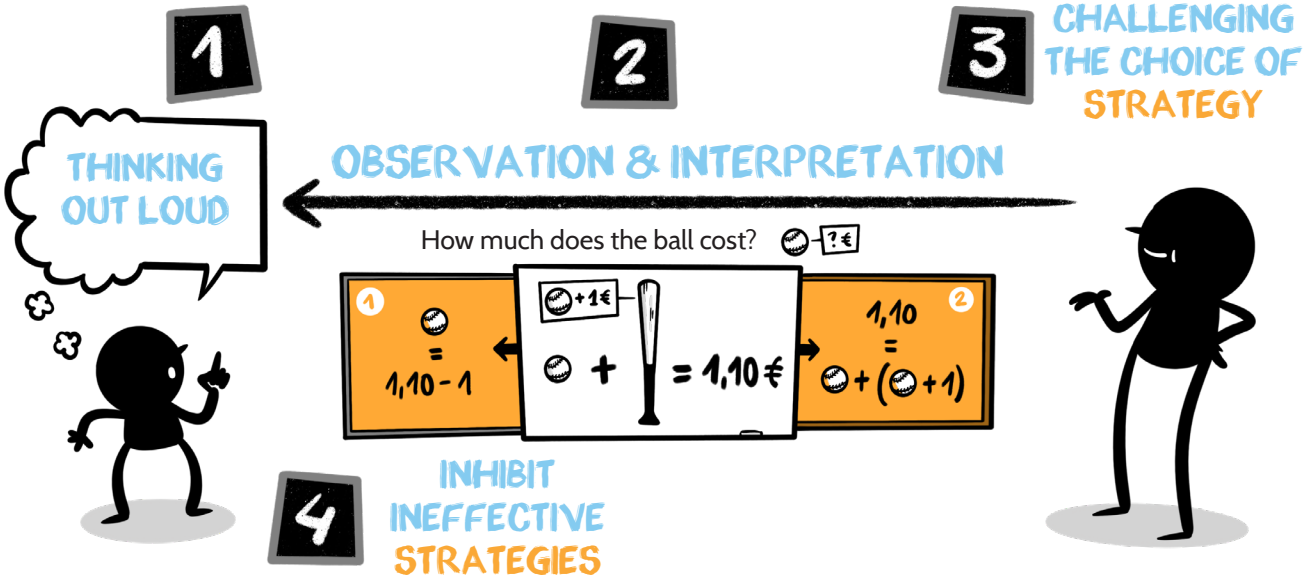
What examples of metacognitive dispositions do I model to my pupils and colleagues, in particular related to intellectual humility?

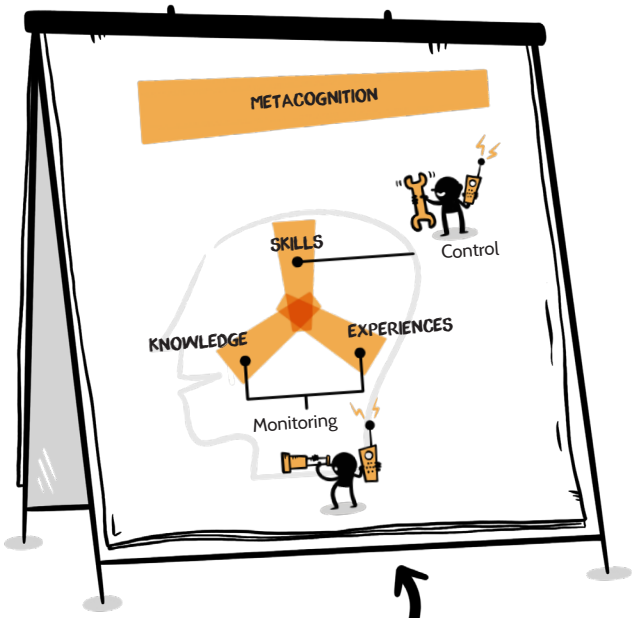
To what extent am I disposed to use my own metacognition in demanding situations?

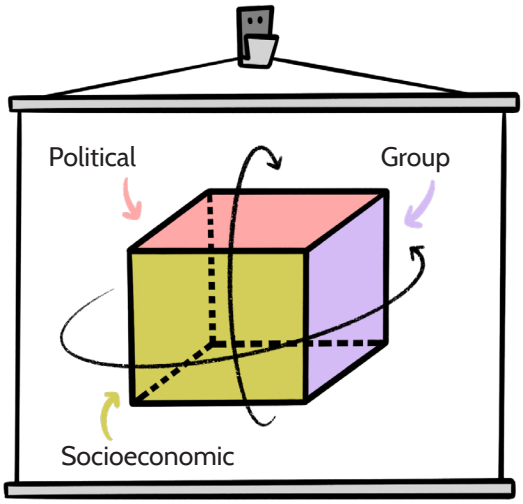
How can I put realistic follow-ups of the evolution of pupils' metacognition into place?

How can I collaborate with colleagues in other subjects in order to try to develop pupils' metacognition on multiple topics and to make connections between them?





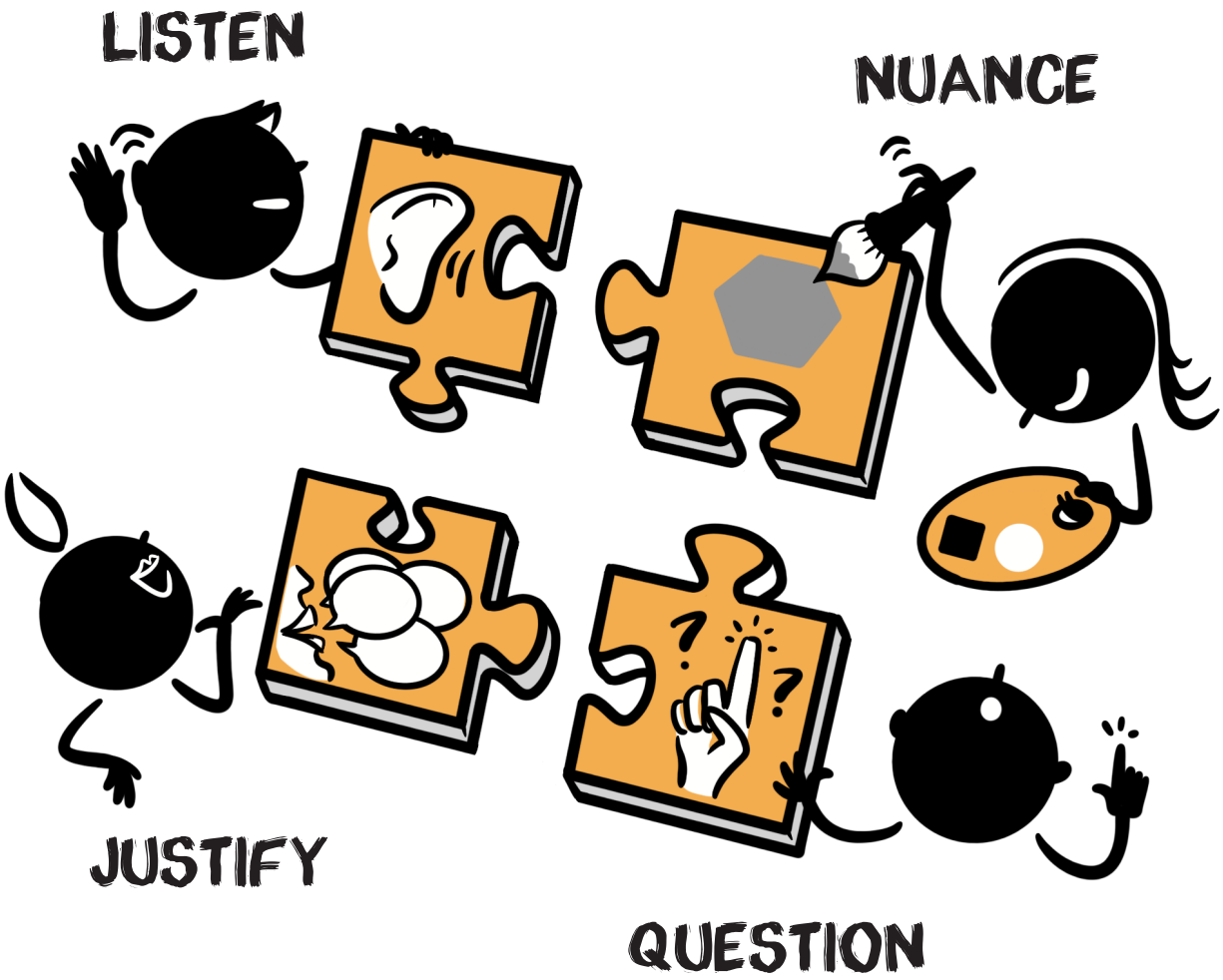




Additions on top of metacognition

METACOGNITION & REFLEXIVITY

Argumentation : provide reasons to justify a point of view within a validity domain



IN SUMMARY

- It is best to teach pupils what constitutes sound argumentation and good arguments* over teaching them about fallacies.
- A good argument is characterised by its content and functions, certain components of which are specific to socioscientific issues..
- An important objective is for pupils to assimilate argumentative norms (commonly agreed-upon rules regarding what makes for sound argumentation), in particular so that changing one's mind is not perceived as "losing face".
- Critical integrative argumentation* suggests integrating arguments, counterarguments and rebuttals, relying on critical questions to assess the strength and cogency of arguments.
- Kuhn's dialogic argumentation aims to make pupils with conflicting opinions on a topic work in pairs, first as a verbal dialogue, followed by a written one including their arguments and counterarguments.
- The practice of whole-class philosophical dialogue aims to develop thinking skills in pupils of different ages thanks to a dialogue centred around a philosophical question.
- It is important to avoid pupils feeling offended. To achieve this, we can provide context to the topics and teaching goals, along with choosing debate topics that anticipate pupils' emotional reactions.

A wide range of studies on critical approaches education place a significant importance on argumentation at a variety of educational levels (Kuhn, 2019; Gagnon & Michaud, 2021; Nussbaum, 2021; Rapanta & Felton, 2022), both for assessment and for the production of arguments. We think that making pupils take part in dialogue with each other (and thus produce and assess arguments) plays a central role in engaging in critical approaches and developing the requisite knowledge, skills and dispositions. Moreover, argumentation is also a part of a variety of curriculums, all of which tends to justify the importance given to argumentation within this resource.

By argumentation, we refer to a dialogic process of assessment and construction of arguments which can result in a product: an overarching argument (which can be confronted to other overarching arguments) constructed of a set of arguments articulated to make explicit, justify and/or support at least one point of view.

***ARGUMENT:**

See Glossary
The content of an argument is split into several parts (a thesis, a justification) and may have different functions (introducing a new idea, or nuancing an element from a previous argument)

When considering mobilisation of critical approaches in the strict sense, we feel that for socioscientific issues*, an argumentation framework is particularly helpful in a teaching context. Indeed, such issues are characterised by a certain complexity (taking into account a variety of dimensions), involving not only epistemic problems but also ethical, political and social ones. For instance, GMOs or nuclear power raise questions (e.g. for or against?) that become very complex when taking all of these problems into consideration.

***SOCIOSCIENTIFIC ISSUES (SSI):**

See glossary.
Socioscientific issues are characterised by their topics related to society and that they involve sciences and/or technologies They are complex, marked by uncertainty and open.

Yet a common teaching approach in France is to teach pupils to identify fallacies*. As with identifying cognitive biases and debiasing strategies,

***FALLACIES :**

See Glossary.
Fallacies are generally arguments that appear correct or convincing, but are incorrect logically or epistemologically. This can be due to errors (paralogisms) or an intent to mislead (sophism).

whose lack of scientific substantiation we discussed in the previous section, **many elements cast doubt on the effectiveness of fighting against fallacies**.

For example, a given type of argument can be a fallacy in one context but not in another. Typically, an argument from authority* can be valid if the source one is drawing from has relevant expertise on the topic and if their statements are not being excessively extrapolated from, whereas if said source does not have relevant expertise then the argument would be a fallacy. Any fine determination would require us to assess the credibility of the source in order to be able to judge if it is a fallacy.

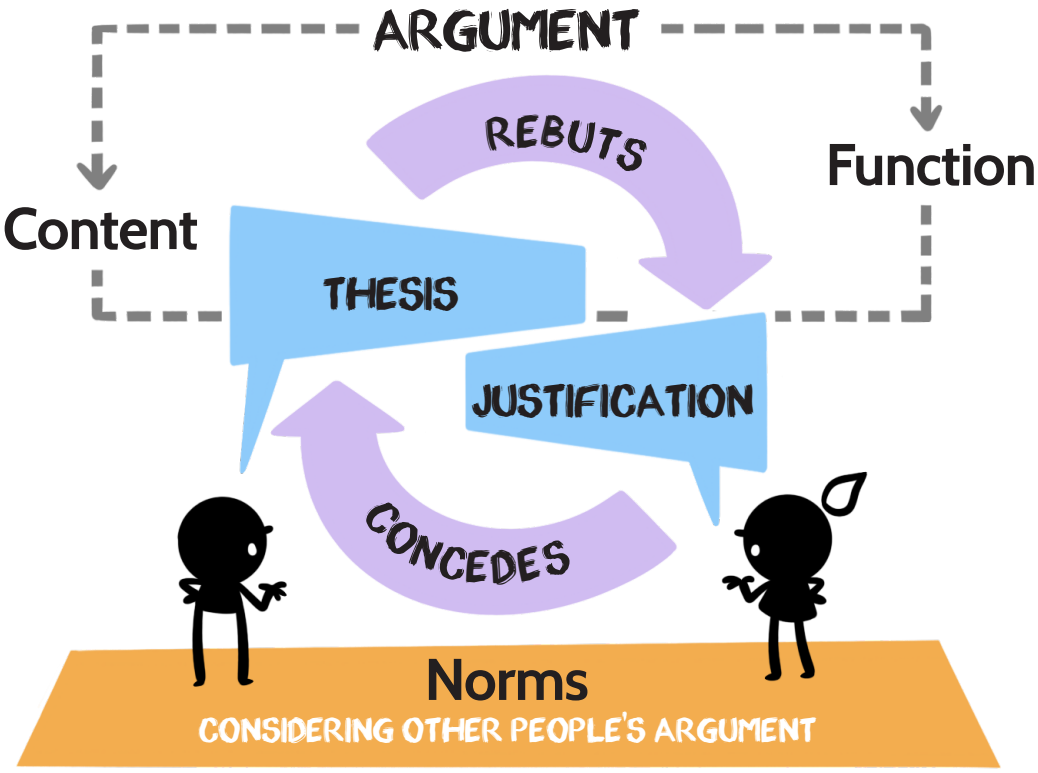
***ARGUMENT FROM AUTHORITY**

Argument which aims to justify the supported thesis on the basis of a claim to the legitimate authority (e.g. scientific, coercive, statutory, etc.) of a given source of information.

Moreover, there is a very wide range of fallacies: as a teacher, being able to correctly identify them all is in itself a sizable challenge (Pallarès, 2019). Furthermore, a sometimes observed inclination to hunt for fallacies in what others say, rather than focusing on improving one's own argumentation, seems inconsistent with both the challenge of developing argumentative dispositions and that of charitably taking others' arguments into account (as per the concept of charity, in the weak sense, described by Ogien, 2002).

Finally, **the didactic challenge is not simply of allowing pupils to identify what is wrong with an argument, but to be able to understand and produce good arguments**. This is why the remainder of this section will focus first and foremost on scientific studies relating to producing and assessing sound argumentation.

But what characterises a good argument? And how can we observe its characteristic elements in our pupils? Pallares (2019) puts forward a schematic representation of an ideal dialogic argumentation between two people discussing socioscientific issues. To judge the quality of argumentation, we rely on criteria about both the content of each argument, but also its function within the argumentation.



Contenu de l'argument (inspiré de Pallares, 2019)

Domains of the socioscientific issue considered in the arguments (Scientific, Technical, Social, Economic, Political, Axiological - i.e. related to values, Sanitary and Environmental)
Accounting for the uncertainty and openness of the socioscientific issue by including statements expressing reservations on the validity of information ("we are not completely certain"), reservations on the possibility of finding a fixed answer anytime soon ("we do not yet know", "more research is needed"), reservations on the sources used, etc., and taking into account the relativity of values appealed to, the diversity of points of view ("true for you, but..", "some people…") and the diversity of actors ("for X, the main issue is…").
Acceptability of the content brought to bear in arguments (no content that is obviously incorrect, for factual elements, or fundamentally unacceptable, when it comes to values).
Providing a **validity domain** ("in some cases…", "in the case where…", "especially when…", "in some people…") or **elements that consciously express one's degree of certitude or of nuance** (phrasing such as "partially", "probably", reasonably", or modal verbs such as "tend to" or "it might be").

Function of the argument relative to another argument (based on Pallares, 2019)

Develop the point made in another argument
Acknowledge a point made in another argument
Nuance an element from someone else's argument
Rebut the thesis of another's argument, in order to invalidate it
Refute the justification underlying someone's argument
Question someone's argument, either to ensure you have understood their point correctly (explanatory questioning) or to challenge and assess their arguments (critical questioning)
Put forward a new idea (new alternative, new concept, new question aiming for exploring in further depth)

A core goal of argumentation activities in the classroom is to help pupils to understand and absorb certain norms of argumentation practice . Bächtold and colleagues (2023) lay out three generic norms and three specific norms in the context of socioscientific issues, presented in the following table.

Norms of argumentation

Generic	Specific to socioscientific issues
Claims made in an argumentation must be supported with one or more justifications	Argumentation on a socioscientific issue must take into account and put in relation its multiple aspects
The arguments expressed by the other interlocutors who take part in the argumentation must be considered in the construction of one's own arguments	Argumentation on a socioscientific issue has to consider the uncertainties inherent to the knowledge called upon, as well as the uncertainties concerning future evolutions in the world
The various claims and justifications formulated in an argumentation should be questioned	Argumentation on an socioscientific issue has to acknowledge the multiple acceptable viewpoints of the different stakeholders of the socioscientific issue

It is therefore possible to work with pupils on a variety of different aspects of argumentation: the norms of argumentation (progressively acquiring new norms made explicit), the content of an argument (progressively

making use of new content) and the function of an argument (progressively utilising new functions).

It can be interesting to observe the potential presence (and number) of each argument function and each piece of content of this argument. These can help with identifying the progress of pupils - we would hope to see the number of well constructed arguments increase, with more varied functions and more elaborate content.

Critical integrative argumentation*: a promising form of collaborative argumentation

Among the other promising studies on practical ways to work at argumentation, the recent work of Nussbaum (2021) on argumentation related to critical approaches allows us to overcome some difficult points: how does one judge the quality of an overarching argument, other than the number of constitutive arguments? Specifically, he suggests a collaborative argumentation framework, that is to say one in which participants work together to build and critique arguments with a view to gaining a better mutual understanding of the subject. Collaborative argumentation notably allows participants to change their mind over the course of the discussion, to make concessions or to position themselves in an in-between space. The form or argumentation is sometimes opposed to conviction argumentation, in which the goal of a debate would be to persuade the other participants by having better arguments.

***CRITICAL INTEGRATIVE ARGUMENTATION:**

See Glossary.
Nussbaum describes the integrative dimension as being the integration of counter-arguments and their refutations. The critical dimension refers to critical questions we must ask.

While the idea of "better arguments" could be interesting in an educational context, the perspective or the goals of argumentation can evidently change. Of course, there are many forms of argumentation between collaborative (or deliberative) argumentation and conviction argumentation. Positive results can in fact arise from each form of argumentation. Both rely on the need for participants to disagree in order to compel them to argue with the ultimate goal of overcoming these disagreements.

One inspiration of critical integrative argumentation comes from the work

of Walton (1996) who classified 60 types of arguments, called "argumentation schemes", that can be seen as families or categories of arguments. Each argumentation scheme corresponds to a set of critical questions that can serve to assess the quality of a given type of argument (Nussbaum, 2021). Nussbaum often cites the example of the Argument from Consequences, the substance of which is that one should act based on the expected positive consequences of that action. The following are three questions which, according to Walton (1996, p. 76-77), correspond to this argumentation scheme:

> « 1. How strong is the likelihood that these cited consequences will (may, must, etc.) occur? 2. If A is brought about, will (or might) these consequences occur, and what evidence supports this claim? 3. Are there other consequences of the opposite value that should be taken into account? »

While it is useful, this model does not give any indication what a sufficient answer to each critical question might be; thus, other epistemic and moral criteria must be taken into account (Nussbaum, 2021). Likewise, we agree with Nussbaum's conclusion that making students (and teachers!) learn more than 60 types of argument and their critical questions is overly ambitious. He instead puts forward a limited list of frequently occurring critical questions that are common to multiple argumentation schemes. These questions seem to us to be able to help both pupils and teachers assess arguments along several criteria. **The following table contains an adaptation of his list of critical questions for assessing arguments** (Nussbaum, 2021), which overlaps with several of the elements proposed by Pallarès (2019).

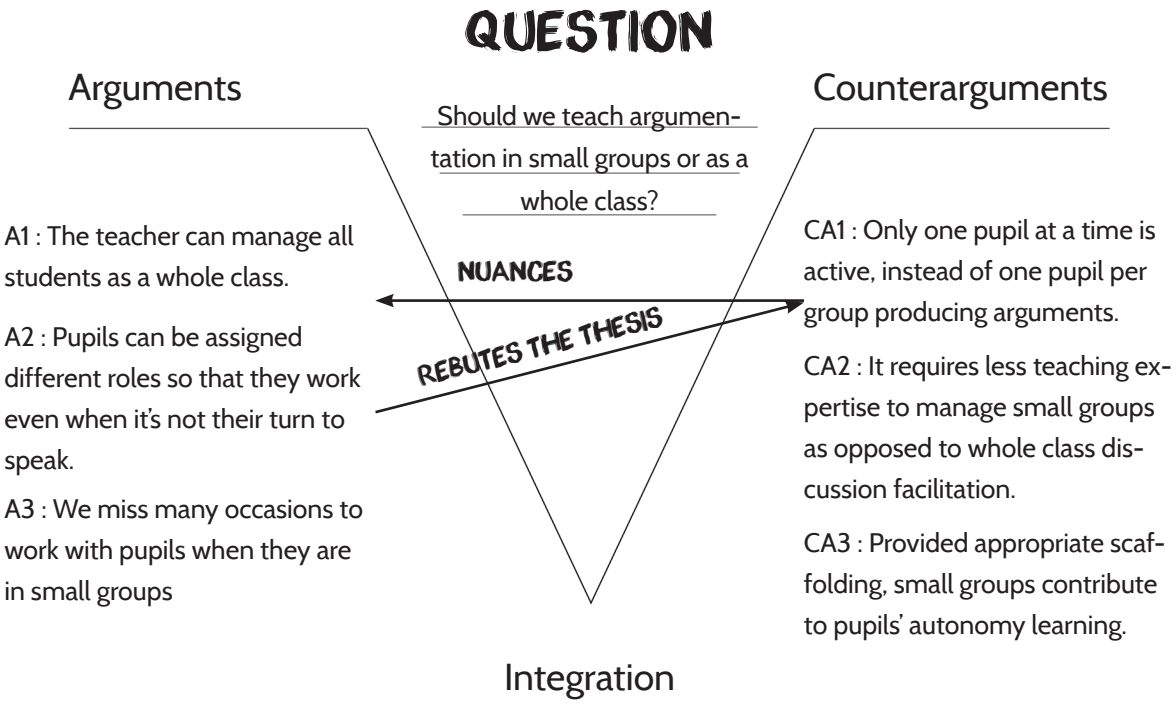
Topic	Critical questions
1. Structure	For each argument: Can you highlight the thesis? Can you place the justification between parentheses? Can you put an asterisk by phrasings that express a validity domain ("in some cases…", "in the case where…", "especially when…", "in some people…"), modal terms ("partially", "probably", reasonably", "tend to" or "it might be"), or other forms of nuance ("we are not completely certain", "we do not yet know", "more research is needed", "true for you, but..", "some people…", "for X, the main issue is…")?

2. Argument acceptability	Do the thesis or justification contain anything that might be shocking (unacceptable if one holds certain values) or completely incorrect?
3. Reasoning consistency	Does the reasoning followed for each justification seem clear, relevant and convincing, assuming any given sources are reliable?
4. Source reliability	Do the justifications rely on sources and references that seem trustworthy?
5. Facts and values (expert level)	Can you differentiate between facts ("Studies on GMOs do not demonstrate a danger to human health"), their interpretation ("Consuming GMOs is not dangerous to our health"), and values ("We should not play God and change plants' genomes")?
6. Alternatives (expert level)	Are there any other assertions or conclusions also supported by the arguments? Can you reject any different or competing assertions or conclusions?
7. Completeness (expert level)	What are the gaps or weaknesses of each argument?
8. Overall quality	*Is one point of view more sound than the other?* *If not, is there a possible compromise, OR should we imagine an alternate solution?*

Depending on the subject during which an argumentation activity will be taught, it may be useful to differentiate between scientific or theoretical arguments on the one hand, and practical arguments on the other. The first can be contained within the second, whereas practical arguments are specifically tied to values or goals. This distinction might lead you to adapt the critical questions (by adding or removing some), based on what seems pertinent to the theme and the context of the argumentation activity. Within classroom-level discussions, Nussbaum (2021) suggests using argumentation Vee diagrams, as in the following example inspired by his work.

In this argumentation Vee diagram, a general question is placed in the centre with arguments and counterarguments on either side. It includes rebuttals

of arguments and counterarguments directly on the diagram. However, to determine which side is more convincing than the other, Nussbaum (2021) identified the need to add critical questions to provide additional criteria to pupils.



One limit to argumentation Vee diagrams and the idea of comparing both sides is that some topics have more than two sides. Notably, socioscientific issues can have up to 8 domains to account for (Pallares, 2019). In order to minimise complexity for pupils, one option could be to make different groups work on different domains at first, and eventually bring together all the arguments and counterarguments. The whole class can then come back to the initial socioscientific issue, integrating all of its dimensions by building on the argumentation developed by each group. While it may not be possible to touch upon all the domains of a socioscientific issue, we feel it is important to at least remind pupils of what may not have been addressed.

PRACTICAL EXAMPLE

Challenge name

How can we develop pupils' oral argumentation skills on socioscientific issues? (FR)

Challenge goals

Prepare for various oral exams (in France: the Grand Oral, oral exams for the brevet, PASS, or others). Foster learning through argumentation, notably by teaching pupils to engage in critical approaches on socioscientific issues.

Action title

Use argumentation Vee diagrams with critical questions (FR)

Dialogic argumentation: an approach focused on dialogue between pupils

Kuhn (2019) views dialogue as fundamental to critical approaches. She notes that it is very difficult for many teachers, not trained in this approach, to moderate whole class dialogues. As it seems unlikely that every teacher will be trained in such methods and be able to practise until they become comfortable with them, she instead suggests taking advantage of the potential of student dialogue, in pairs or two to a side. In her work, **Kuhn (2019) suggests starting from alternating dialogue between two pupils holding contradictory positions. This peer-to-peer discourse can take two forms: either written, via a digital interface; or verbal, in real time.** The former provides a written record of their discussions and gives pupils more time to think and structure their ideas, for example by using resources touched upon in class. The latter lets pupils get used to the norms of argumentation and dialogue, allows them to base themselves on their interests and lived experience, and gives meaning to the argumentation through real-life interaction with a partner.

The challenge of motivating pupils to take part in a dialogue depends on multiple factors, but having flesh and blood partners seems important (Kuhn, 2019). In comparison, the written form enables pupils to mobilise information from class over their personal opinion, which highlights the importance of developing both forms of dialogic argumentation alongside each other. One way to implement this could be to ask pairs of pupils to write an essay on a topic on which they each hold a different position. The requisite negotiation in order to bring this task to completion should support their learning.

We feel that dialogue between pupils for the purpose of producing a written piece is quite compatible with Nussbaum's (2021) suggestions relating to critical integrative argumentation. We might envision providing pupils with an argumentation Vee diagram in which each student can clearly state their arguments, then ask pupils to use critical questions (perhaps adjusted by the teacher according to the specific learning objectives) in order to improve this argumentation, and finally write up a shared written version.

A whole class approach for all ages: philosophy for children and teenagers

Among approaches to teaching argumentation, those of philosophical dialogue (Gagnon & Michaud, 2021) and of discussion to democratic and philosophical ends (Tozzi, 2021) emerged as early as the 1970s in various forms. In France, moderators, either teachers or other school staff, would organise a form of whole class argumentation from kindergarten to the end of secondary school. This initially followed the framework developed by Lipman & Sharp (1978), a goal of which was to develop critical thinking, and which was based on a philosophical novel adapted to the age of the class which could be read either by the pupils in turn, or by the moderator. The moderator would then collect any questions the pupils had on the philosophical novel's content. All of the questions were then put to a vote in order to decide which question would serve as the jumping-off point for a discussion among students, with the guidance of the moderator.

Today, **there are a variety of models of philosophy for children and teenagers**, targeted at different ages and relying on supports other than that initial philosophical novel, or no support at all, and sometimes give roles to pupils such as observer or keeper of the time. The task of moderating also

varies depending on the approach taken, with a variably involved **moderator who can directly push students to improve their thinking abilities** such as "giving an example" or "providing one's reasoning" (Sasseville & Gagnon, 2012). One characteristic of these approaches that distinguish them from those of Nussbaum (2021) and Kuhn (2019) is their **whole class organisation**. While this does confer some benefits (for instance, the moderator can easily provide information to all students in order to structure dialogue), a primary limitation is that this requires significant training and practice for any teacher who wishes to use it in class. Another limit of these philosophy workshops, as pointed out by Gagnon and Michaud (2021, p. 53), is that "appeals to external sources of information remain fairly limited". As these workshops historically took place almost exclusively orally, the information invoked by pupils to justify their arguments was mostly internal, and thus related to preexisting knowledge. Recently, the work of Blond-Rzewuski & Renard (2023) has opened the door to a written philosophical practice that complements existing philosophy workshops for children and teenagers, suggesting on the whole that these different approaches are complementary, in line with Rapanta and Felton (2022).

The role of emotion in argumentation

Many of the aforementioned studies emphasise the importance of confronting different - or even contradictory - ideas when working on argumentation (Kuhn, 2019 ; Nussbaum, 2021), which could lead to cognitive conflict. Other studies note the importance of recognising the emotional dimension of argumentation, whether positive or negative (Polo et al., 2016). Of particular note is that **when one person in a group feels offended, this tends to inhibit group reasoning** (ibid). It is therefore very important to ensure that pupils feel comfortable expressing ill-structured ideas or changing their minds, and do not show aggressiveness in criticising others' views, nor sadness at not convincing everybody that their initial idea was the best (ibid). This idea of associating positive emotions to the argumentation context can be linked to the concept of self-correction, important for critical approaches (Lipman, 2003 ; Gagnon & Michaud, 2021), particularly at the group level.

In social situations such as that of argumentation, **pupils will have different strategies to "keep face"** (Goffman, 1974, cited by Polo et al., 2016). These strategies can include hiding certain emotions or working towards differ-

ent goals during the argumentation: seeking consensus to avoid conflict, getting one's opinions to "win" against others, etc. Within the framework of critical integrative argumentation (Nussbaum, 2021) or of dialogic argumentation (Kuhn, 2019), it seems important that interactions remain both critical AND constructive, with the aim being to advance the group's thought process over "being right", and thus that "keeping face" becomes tied to being able to contribute to the group's joint reflection.

If we want positive emotions to enhance the constructive character of an argumentation, we must ask what role the teacher and the argumentation environment can play in fostering positive emotions. It seems that **working on the norms of argumentation is important. If pupils have absorbed the idea that they have the right to make mistakes, that it is a good thing to change their mind when presented with convincing arguments, then they will be less likely to associate this with "losing face".** This can relate back to tasks on dispositions, such as keeping an open mind or mental flexibility, by highlighting the value of these behaviours in various learning contexts.

Moreover, it is important to provide clear argumentation rules to students for each activity they are to do, with these rules including awareness of others' emotions. Integrating new norms of argumentation can take time, and to that end we suggest following the recommendations put forth by Kuhn (2022) touched on in the metacognition section. She suggests starting with "colder" topics, where the emotional charge of changing beliefs or opinions would likely be lower. This allows for integrating norms of argumentation such as valuing changing one's mind, as well as listening to and considering other people's feelings, which in turn will make it easier to apply these ideas to more sensitive topics and contribute to making the classroom an environment of mutual trust. However, lower emotional investment could also risk students disengaging from the class, if the theme is uninteresting to them. This is why Polo and colleagues (2016) recommend simultaneously **choosing argumentation topics that anticipate pupils' emotional reactions, and contextualising the topic and the learning objectives.**

In conclusion, while there is no single model for taking into account in argumentation applicable to all situations, the aforementioned research seems to at least indicate some promising avenues, which will need to be adapted by every teacher based on their teaching objectives and their pupils' level of knowledge.

QUESTIONS FOR FURTHER EXPLORATION

Am I comfortable with what an argument is, and what good argumentation is, particularly as relates to socioscientific issues?

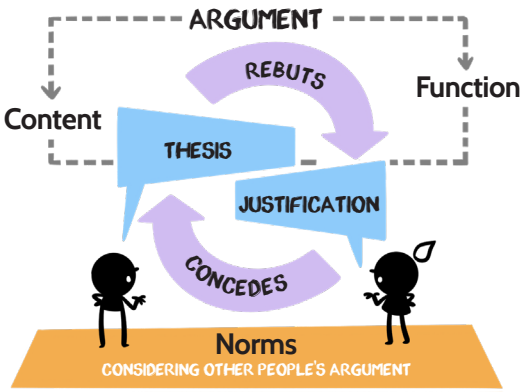
What norms and dispositions for collaborative and constructive argumentation should I work on with my pupils?

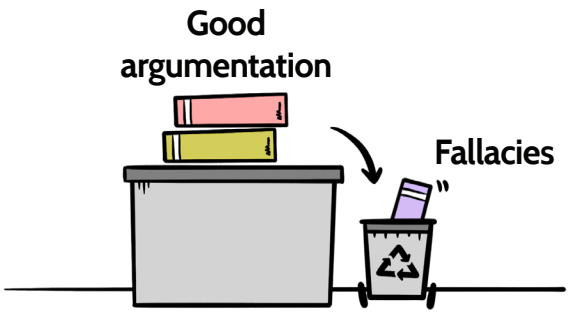
What already established practices do I have for student argumentation, and how can this resource help me develop these practices?

Could changing my stance help my pupils work on argumentation?

Do I know how to use this resource to make pupils work in pairs, in small groups or as a whole class, whichever suits me best?

Which curriculum topics could I develop argumentation activities around? For which questions would this be most appropriate?



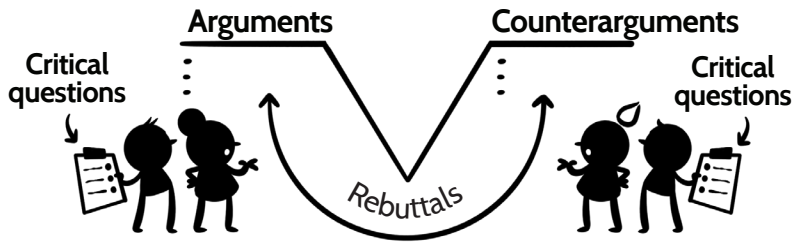


Argument = Content + Function + Norms

Argumentation context

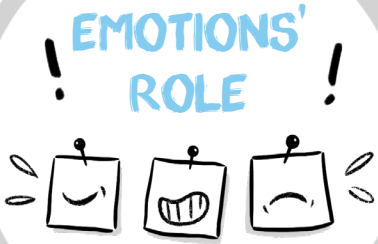
A	B	Q	S	S	Y	Z

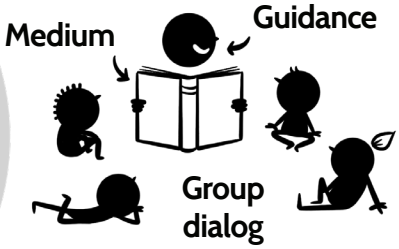
conducive to



CRITICAL INTEGRATIVE ARGUMENTATION

DIALOGIC ARGUMENTATION

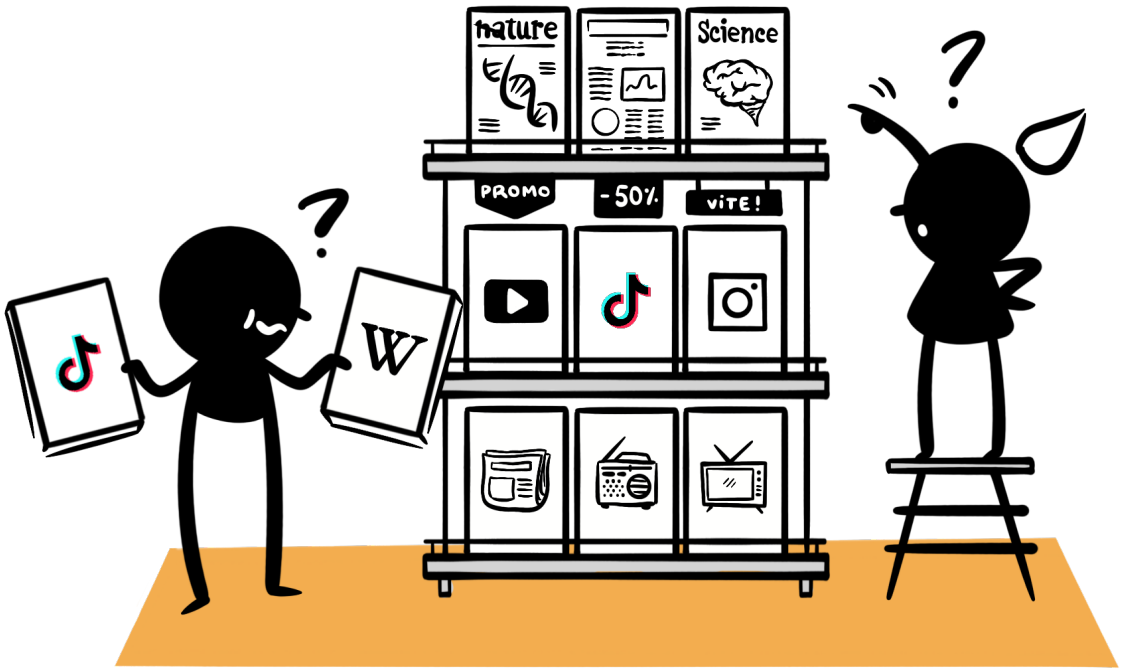




PHILOSOPHY FOR CHILDREN / TEENS

ARGUMENTATION

Searching for and evaluating information. Beyond media literacy



IN SUMMARY

- Alarmist discourse about fake news is not scientifically grounded and it seems preferable to focus more on what an information implies than on its truth value.
- It is important to take young people's informational experience into account and to work on emotions to encourage them to find and evaluate information with critical approaches, even outside of school.
- Ideally, information research can be thought of as driven by an intent to be informed arising from some form of uncertainty. This information research evolves and stops based on its cost/benefit ratio.
- A humble teaching stance regarding the informational practices of young people lets one see value in pupils' experiences and to learn from them.
- We can set apart assessing the reliability of a source of information based on skills (expertise and reputation) on one side, and its trustworthiness (reputation and vigilance) on the other.
- Searching for and evaluating information relates to metacognition, with our relationship to knowledge or with argumentation and can be jointly worked on.

Fake news: a real problem or alarmist discourse?

A widespread view of fake news characterises them by the intention to deceive and not simply the incorrectness of the information (Tandoc et al., 2018, Gelfert, 2018). However, intention is hard to verify in practice. Other terms such as misinformation sometimes refer to the simple spread of false information without intent to harm (Altay, 2022). While it is undeniable there is a flow of false information, it would be reasonable to interrogate what real harm they represent.

Due to methodological issues in some studies and to improper generalisation of the results of certain studies in the media, the current fear of fake news is characterised by many researchers as a moral panic (see Altay et al., 2023). For instance, a study by Mitchell and colleagues (2019) seems to indicate that US residents are more worried about misinformation or fake news than they are about sexism, racism or the impacts of climate change (Altay et al., 2023). When compared to these phenomena that have, or will have, dramatic impacts on hundreds of millions of people, it seems important to question public policies or financing dedicated to fighting fake news that do not consider the contributions of current research.

Rethinking misinformation in light of research

Altay (2022) puts forward **several arguments supporting the idea that the dominant conception of fake news in our society is mistaken, and what lessons to draw from this.** This contribution is essential to conceiving of a critical approach to finding and evaluating information that is both appropriate and effective. Here are two of the arguments the author develops in his article.

Firstly, online information consumption is fairly low (around 5% of internet activity), of which a very small proportion could be considered misinformation, leading to an average consumption of misinformation of around 0.15%. Fighting against it runs a greater risk of teaching pupils to be overly cautious and reject true information, than of accepting incorrect information.

Secondly, **this distinction between true and false information is itself problematic, as information might be true but misleading, and information might be false but have no negative consequences**. For instance, saying that men more frequently die violent deaths than women is true,

but could be used to minimise violence against women. This information is misleading as it fails to mention that the majority of those violent deaths are caused by other men, which would legitimise the desire to reduce male violence. In contrast, it would be false to say that creating this resource was easy, but it is unlikely that believing that it was would change your life in any way. Ultimately, **misinformation is above all a symptom of a larger issue: our relationship to the institutions that produce and distribute information. Lack of trust in media or scientists is a major factor in the adoption of alternative viewpoints that rely on false information**. In other words, if someone is convinced that "the system is set against them", they will be more likely to accept any information aligned with this position, whether true or false.

One of the lessons that Altay (2022) encourages us to draw from for a critical approach to information is in fact very different to the widespread view: instead of teaching pupils to be wary of false information, it would be best to teach them to better identify why certain content can be misleading.

PRACTICAL EXAMPLE

Challenge name

How can we help pupils to analyse the processes used to shape information? (FR)

Beyond working on the problem individually, Altay (2022) encourages us to consider it at a societal level. Since we know that much misleading content is produced by institutional figures or influential people, it seems less efficient to demand a critical approach of each individual than to deal with the problem at the source by avoiding conflicts of interest and asking for more transparency. Though we may not all have the same values, political opinions, or tastes in our information diet, having a critical approach to our relationship to information and to the people and institutions that distribute it might, however, be something we have in common. Let us therefore clarify how research findings can help us find and evaluate information instead of fighting against fake news.

A cognitive view of finding information

Cognitive psychology and ergonomy have contributed to developing a model of information research that was described in detail by Boubée and Tricot (2010). A characteristic of this model is that **at the base of all information research, the authors describe a need (or desire, intent) to be informed arising from some form of uncertainty**. This uncertainty implies having prior knowledge, as it stems from a discrepancy between some pre-existing knowledge and a "complex task" (Boubée & Tricot, 2010, p. 27) or a problem to solve.

It is important to note that "teenagers mostly expect online information to reduce their uncertainty" (Jehel & Saemmer, 2017, p. 77). At any rate, uncertainty is an interesting teaching tool which we should not seek to suppress. With this in mind, information research amounts to assuming that the (time or energy) cost of such research is less than the perceived value of the result.

A critical approach to information research could thus include a reliable assessment of this cost/benefit ratio. One consequence of this view is that in many cases, seeking further information is not necessary. In all sorts of situations where the consequences of being mistaken would be minor, it would be reasonable to satisfy oneself with the most easily accessible information. Typically, researching restaurants one might go to does not have the same stakes as finding out about political parties to decide who to vote for, or for a judge who will have to decide whether someone is guilty.

This assessment of the cost/benefit ratio implies a certain level of knowledge about information research itself, such as being familiar with search

tools (e.g. Google, Wikipédia, a specialised database, etc., but also a reflection on the research goals, in order to evaluate its consequences and thus in part its importance (Boubée & Tricot, 2010) . These authors differentiate between "a conceptual component (what semantic content do I seek?) and a procedural (what series of actions will allow me to reach my goal?), or even informational (what need for information must be satisfied?) component" (Boubée & Tricot, 2010, p. 32) to the aims of information research.

One could therefore work with pupils on these different dimensions: first guiding them to clarify their goal (what am I going to search for?) then making them think about how to reach this goal (how am I going to search?). The role of prior knowledge can be illuminating: knowledge about the research themes will allow them to refine their goal (this knowledge lets them better choose where and what to search for) while knowledge on the information system will improve the procedure (this knowledge lets them better choose how to search) (Boubée & Tricot, 2010).

Limits of the cognitive approach and young people's actual practices

Information research, thought of as voluntary and answering a need, has one major flaw: it does not correspond to a major part of young people's relationship to information, as seen in the work of Cordier (2019). Indeed, as she states "Information research as practised by these young people is characterised by an important ludic dimension." (Cordier, 2019, p. 9). Young people are exposed to information via social media where platform design reinforces this ludic aspect, but also through television or word of mouth for example (ibid).

Information research as done in a school context can sometimes come in opposition to young people's informational practices in the personal sphere. As Corder writes "evaluating information is perceived by the young people I encountered as an academic imposition, a strictly school-based norm and not an intellectual process that is part of a more global critical approach to information. The practice of evaluating information is, for them, strictly tied to the academic context." (2019, p. 7)

Students do not start from scratch and have some experience related to documentary research (Boubée & Tricot, 2010). Sahut (2017) notes that information reliability and source authoritativeness are often deemed sec-

ondary by young people, even though they are two important dimensions of critical approaches to information. The risk lies within the criteria they typically use, that are often related to appearance and to images, given that young people rarely engage in an analytical process of the source's quality when they are faced with information (Boubée & Tricot, 2010; Sahut, 2017).

PRACTICAL EXAMPLE

Challenge name

How can we help pupils to have a critical approach to images spread in the media? (FR)

These various points lead us to ask how we can **consider pupils' informational experience** in order to support their learning of critical approaches in a media literacy context. Taking into account the teaching context can especially increase the probability of them reproducing what has been learnt outside of school. For instance, if students primarily access information on their smartphones, while lessons only take place on computers, this will create a barrier to them engaging in critical approaches across different contexts. This discrepancy between pupils' spontaneous information-seeking practices and the school's ambition in terms of developing information evaluation

skills points to **a priority for developing critical approaches to information research: developing dispositions to find and evaluate information.** The emphasis placed on developing such dispositions is consistent with Altay's (2022) work showing that erroneous beliefs could be more a product of lacking some information than of an exposition to false information. Making pupils want to find diverse information (which would require more effort than that coming from their spontaneous practices) before they even critically analyse it might in fact be the foundational block of a critical approach to evaluation if we want them to apply this approach out of the school context. But Cordier (2019) notes that it is not sufficient to be exposed to diverse information in order to develop the knowledge and skills needed for information research and evaluation, and that this risks leading to deepening inequalities.

It is worth underlining that access to some information is uneven: often, scientific articles (primary source for some newspaper articles for instance) are written in English (a barrier to non-native speakers) or in unapproachable jargon, even for teachers, or may even be paywalled. In light of this, it seems necessary to jointly work on dispositions on one hand, and on the other on the skills and knowledge needed for information research and evaluation which can slowly be bolstered. As we know that pupils will not systematically use the informational knowledge and skills they have been taught (Boubée & Tricot, 2010; Sahut, 2017), teaching critical approaches to information cannot be limited to simply developing these.

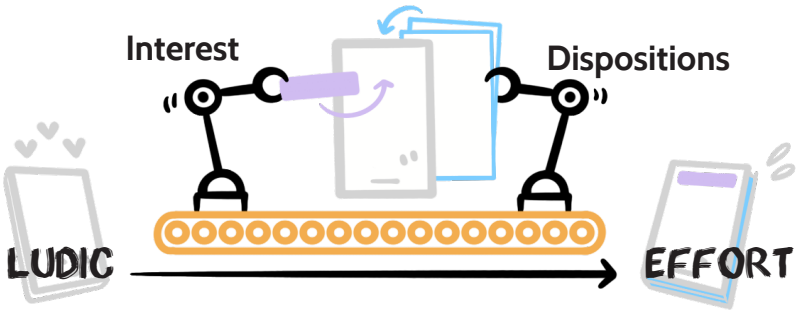
Making pupils want to search for information

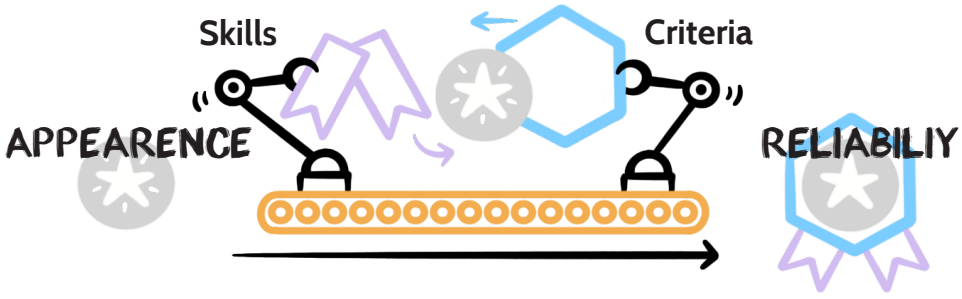
The role of emotions in information research is central, to the point that Boubée and Tricot state that "there could be no information research without emotions" (2010, p. 222). However, these very authors speak of the complexity of doing research on the role of emotions in information research and evaluation. Returning to the work of Cordier (2019), we see that in young people's spontaneous practice, information research is pleasant, as opposed to an overly academic process which is applied mainly to satisfy teachers, but has no intrinsic meaning to pupils.

Moreover, Boubée and Tricot note that "individuals with very little knowledge research less information than individuals who already have some knowledge. The decision to research some information is influenced by having already previously done information research" (2010, p. 127). Consistently with

the importance of knowledge to engaging in critical approaches, it seems important to us to make students practise information research in an emotionally positive way, ideally avoiding deepening inequalities in their relationship to information.

Affective and cognitive dimensions coexist when doing information research and evaluation, but the affective dimension seems to generally have the upper hand (Boubée & Tricot, 2010): an unmotivated pupil who does not find any joy in finding or evaluating information is likely to simply... not look for nor evaluate any information. A major challenge is therefore to associate positive emotions to the information research and evaluation process itself, including within the school context.





Reviewing the scientific literature studying the effect of interventions where pupils were given activities on sourcing highlights the lack of studies linking motivation and the result of working on sources (Brante & Strømsø, 2018). Moreover, as demonstrated by Sahut (2017) or Boubée and Tricot (2010), information research stops once the goal is reached and the effort involved is thus often optimises the perceived cost/benefit ratio, as mentioned previously: it is a balance between information quality and required effort that is

sought, not finding the highest quality information at all costs. If the research is deemed important, then it will be easy for pupils to find meaning in the efforts required for this research. In contrast, if pupils do not see the point of putting effort into the task and their only incentives are higher grades or pleasing the teacher, then it is very likely that the acquired skill will rarely be used outside of class.

Finally, we feel it is important to change one's stance in front of students: many teachers are helpless when faced with digital informational practices with which pupils seem far more comfortable than them. It is preferable to take the stance of the "ignorant instructor" (Rancière, 2004/1990), which involves teachers, who do not possess all knowledge, letting go and engaging in a process of jointly questioning and building knowledge and skills with pupils (Cordier, 2019). While maintaining an understanding and kind stance, it is then possible for teachers to learn from their pupils and to find value in their expertise, while providing them with pedagogical skill and reflexivity regarding information research and evaluation.

Models of information evaluation

Many methods of representing the goals and progression of information evaluation have been developed by various studies. Sahut describes information evaluation as "a mental operation leading to a judgement on the value of a piece of information. This judgement is based on evidence drawn directly from the source and/or from its semantic content, measured against criteria." (2017, p. 227).

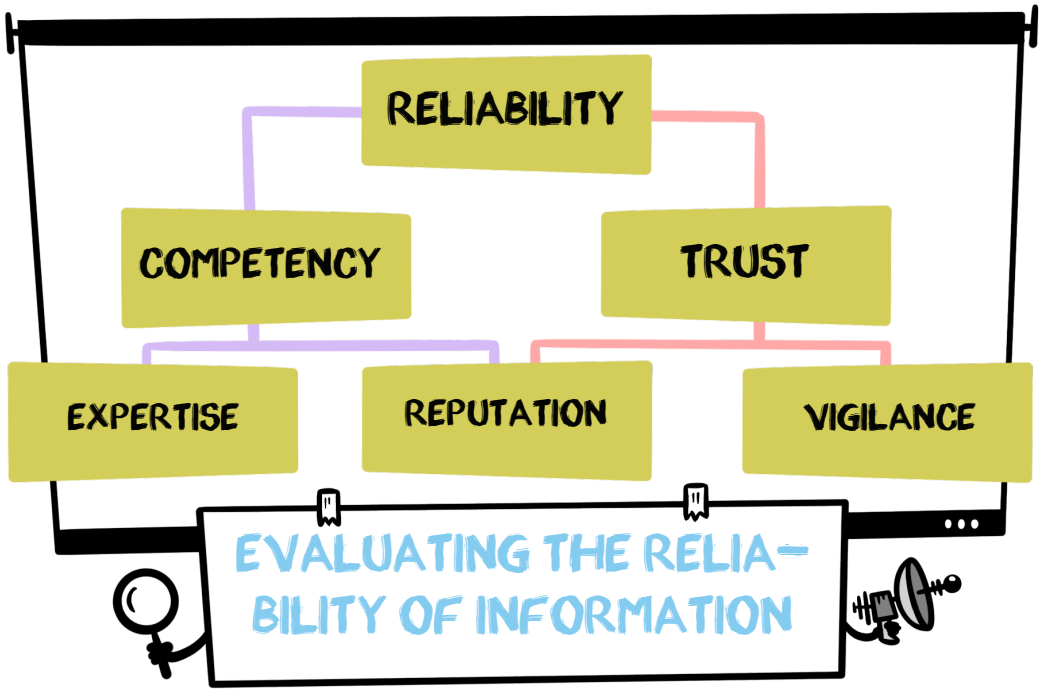
Sahut particularly differentiates between "two broad categories of criteria used during this operation. The first category is that of **pragmatic judgements**. These rely on criteria related to the usefulness of the document and its content, along with its ease of access and of use. The second category is that of **judgements of an epistemic nature**. By this we mean criteria related to the truth value of information offered by sources. It is taking these types of criteria into account that is considered essential to critically analyse information." (ibid).

Considerations of an epistemic nature, being less subjective, more often tend to be the focus of school activities. **We can conceive of working on information content (evaluating the provided arguments) and working on the source (evaluating its reliability)**. However, a first difficulty emerges from the fact that "judgements of a pragmatic nature seem to often prevail over epistemic considerations." (Sahut, 2017, p. 233). In other words, information is often chosen

by students based on its direct utility, its relevance - as we have previously mentioned, sometimes this is on the basis of elements such as its presentation and the presence of images. The finer analysis to determine the information's reliability requires more effort, and is thus less systematically employed.

One activity drawn from Wiley et al. (2009, cited by Sahut, 2017) works on information evaluation with pupils, jointly creating a set of criteria that they consider important to judge if information is relevant and reliable, for instance, using the distinction between the two categories of criteria to classify them.

These criteria can be compared to the model of source reliability evaluation put forward by Geay (2023).



Face with information we want to assess the credibility of, Geay and her colleagues suggest asking two questions, one about t**he competency of the source** which would allow them to share reliable information, and the other on **the trust we can place in them**, a judgement on their intention to share reliable information. Working on competency, as with working on trust, can be subdivided into two parts, one of which is shared between them. The source's competency refers on one hand to the notion of a source's expertise, and on the other to their reputation. Trust in the source can also be viewed through the lens of reputation, but also can be approached through the concept of vigilance. These three criteria can themselves each be subdivided into two: evaluating expertise relies on analysis of the source's knowledge, and also of their performance; for reputation, it is an analysis of their authority and their popu-

larity; and finally, for vigilance, one analyses their interest and engagement.

To fully understand the practical use of these criteria for information evaluation, the idea would be to, in a third phase, apply them to a variety of online texts, in order to make pupils slowly gain mastery over the criteria. Finally, in order to maintain a connection to students' informational practices, a fourth phase could be dedicated to applying these criteria to sources chosen by the students themselves, on their subjects of interest and/or directly related to their every-

PRACTICAL EXAMPLE

Challenge name

How can we enable pupils to evaluate sources across various academic subjects? (FR)

Action 1

Co-define with pupils a list of source quality criteria from the work done on a set of predefined documents. (FR)

Action 2

Interrogate pupils about source evaluation (FR)

day life.

Many other avenues for working on information evaluation exist, for instance in resources offered by the CLEMI, as demonstrated by teaching guides clearly indicating their desire to develop a form of reflexivity or critical approaches as cited by Bosler, "for example, 'applying critical thinking to advertising'" (2016), 'Using Déclic' Critique [a CLEMI framework] to decipher media and counter fake news' (2019.)" (2023, p. 9). However, the author notes the discrepancy between a rhetoric placing importance on considering the informational practices of pupils, and the teaching guides produced

by the CLEMI which she interprets as "adapting to academic expectations" (Bosler, 2023, p. 10). As Sahut (2017) remarks, among the vast array of possible media literacy teaching strategies, very few have been developed based on scientific studies or have been subjected to a systematic impact assessment, despite "the CLEMI positioning itself as a mediator between the scientific community, which produces knowledge about media and teaching practices, and the teaching community." (Bosler, 2023, p. 9). We will therefore present a few other alternatives emerging from research looking to create new teaching practices, along with examples of efforts to teach critical approaches to information based on them.

Pedagogical possibilities

Brante & Strømsø (2018) performed an analysis of 18 teaching interventions targeting sourcing skills that revealed differences based on the school level. Interventions at the primary (or early secondary) level focused on identifying the author of a website, determining their intention and expertise, classifying sites in predefined categories, localising a source of information and evaluating its reliability by triangulating data. Interventions at the late secondary level focused instead on reflecting on the best ways to evaluate source characteristics (their role, their knowledge...), identifying them in multiple documents, identifying the characteristics of a document's form and its postulates/its rhetoric, developing heuristics such as learning about the source, keeping the source in mind while reading the information, and thinking about the source when interpreting information.

Relevant to the previous section of this resource on metacognition, Sahut (2017) invites us to work with pupils to analyse the heuristics being used, in order to determine the relevant and reliability of information they encounter in their everyday life. The idea is that by taking a step back reflectively, one can support pupils in identifying situations in which their heuristics or their "autopilot" mode is no longer adapted and teach them to reinforce helpful heuristics. When specifically looking at heuristics for establishing source expertise, emphasising criteria such as the position of an author, their potential affiliation to a recognised institution (e.g. researchers), and on the contrary pointing out elements that are rarely relevant (e.g. the URL of a website) may be interesting. The idea here is to in some way reinforce a heuristic, which is less costly from a cognitive standpoint than an analytic strategy, and therefore is more likely to be actually used.

All the same it should be noted that, as with any heuristic, it will have limits

and may be misleading in some situations where "rapidly determining if a source is authoritative can be very difficult, if not impossible" (Sahut, 2017, p. 241). However Cordier (2019) emphasises "the pressing need to not reduce sourcing culture to ticking boxes in an information evaluation grid" (2019, p.8), which is essential to not limited source analysis to a mechanical and binary process.

We can also consider a heuristic such as cross referencing multiple sources in order to increase a piece of information's reliability. However, it is important to be careful to not be misleading, as if several media sources are citing each other or reference the same primary source, there would be no reason to judge the information as necessarily being more reliable.

As mentioned in our section on relationships to knowledge, it is essential to not transmit problematic representations to pupils as might be done with an evidence pyramid. Validating source authoritativeness should thus - at the very least - be presented with much nuance and caution. Associating evaluation of a source's expertise and reputation to student reflection on the consequences of making a mistake can encourage pupils to only engage in an analytic process when the stakes are particularly high. In other cases, when incorrectly trusting a heuristic for expertise analysis would have no major consequence, such trust seems reasonable.

A critical approach to what is considered legitimate and authoritative and of the criteria in place for improving one's heuristics usefully complements working with pupils on exploring the problems of defining an authority. Typically, all scientific production is not regarded equally, depending on the epistemology of the researchers who lead the studies and the methods used in them.

An additional difficulty in working on the concept of authoritativeness with pupils arises from the variety of forms of authorship online (Broudoux, 2007): Wikipedia, for instance, does not have a single identified author, so authoritativeness is drawn from referencing institutions, including scientific ones (Sahut, 2015). Likewise, sources of information can be people with jobs or positions that pupils do not know (e.g. public relations officer). The vocabulary used, if it is not familiar to the students, can also limit their ability to evaluate the source's intentions (Macedo-Rouet, 2022). Their prospects of developing a critical approach to information evaluation is thus dependent on prior knowledge and skills (in this case literacy, or informational culture) that can be quite broad.

In a more complex but nonetheless important version, Sahut presents a view

of reliability which requires that "young people should be taught a global critique of systems of knowledge production and endeavour to take marginalised viewpoints into consideration. Being critical thus entails becoming aware that all information is, whatever its source, subjective, and always imbued with the social, political and economic context." (2017, p. 242).

In summary, it is fairly difficult to dissociate working on one's relationship to knowledge and on information evaluation itself. We feel it would be interesting to consider working on epistemic beliefs while examining if a source of information is authoritative, and to add an ethical and political reflection by working with pupils to explore the context and the consequences of different ways of presenting information.

Angles and choices of media literacy themes

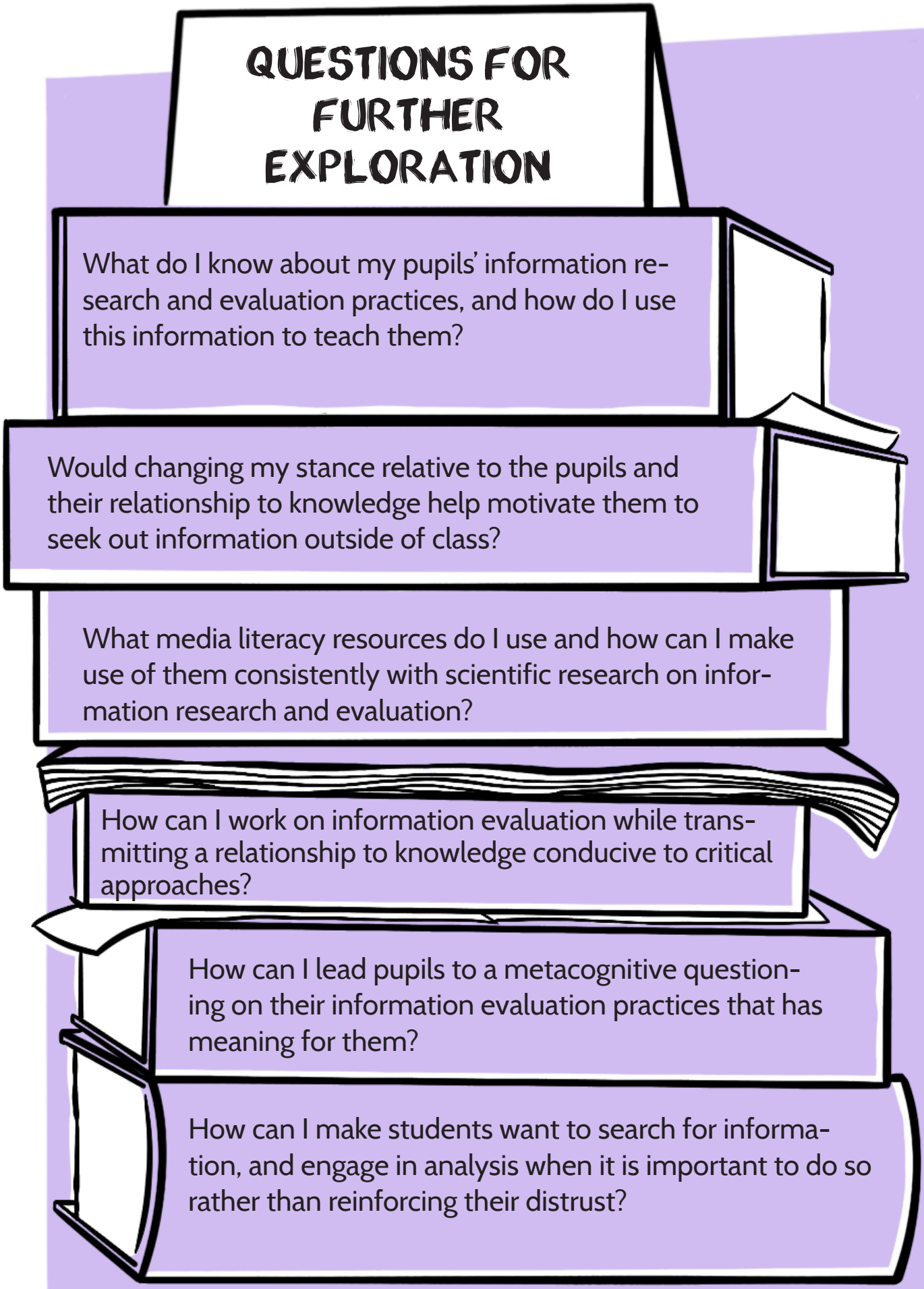
Several researchers have made recommendations on what angles to favour within the context of media literacy lessons. In particular, Jehel and Saemmer mention the "need for a critical approach to the political and economic rationales of digital technology" (2017, p. 56), along with "an awareness of the production rationales invisible to the user." (ibid, p. 64). This is consistent with comments by Desfriches Doria (2018) who refers to the importance of considering the social and political context when evaluating information.

Sahut (2015) has produced inspiring work on the example of Wikipedia and the way representations can evolve (for teachers as much as pupils) as a result of a classroom task involving editing Wikipedia pages. He also emphasises the specificity of working with digital social media, which allow for a kind of objectivised reputation via likes, stars or other systems that quantify engagement (Sahut, 2017).

For their part, Jehel and Saemmer refer to their work on journalistic ethos, which is seens as "a toolkit for questioning the merits of media practices." (2015, p.75). More broadly, we feel that Neveu's (2019) work on journalistic information is enlightening as to the specificity of information distributed this way.

All parts of the reflection on different rhythms and processes of publication, different roles involved in journalistic structures, as well as the socioeconomic constraints that influence them, or even the importance of a free press when facing democratic challenges (Neveu, 2019) could be the subject of an activity that allows pupils to better analyse journalistic information or to differentiate it from other types of information.

QUESTIONS FOR FURTHER EXPLORATION



What do I know about my pupils' information research and evaluation practices, and how do I use this information to teach them?

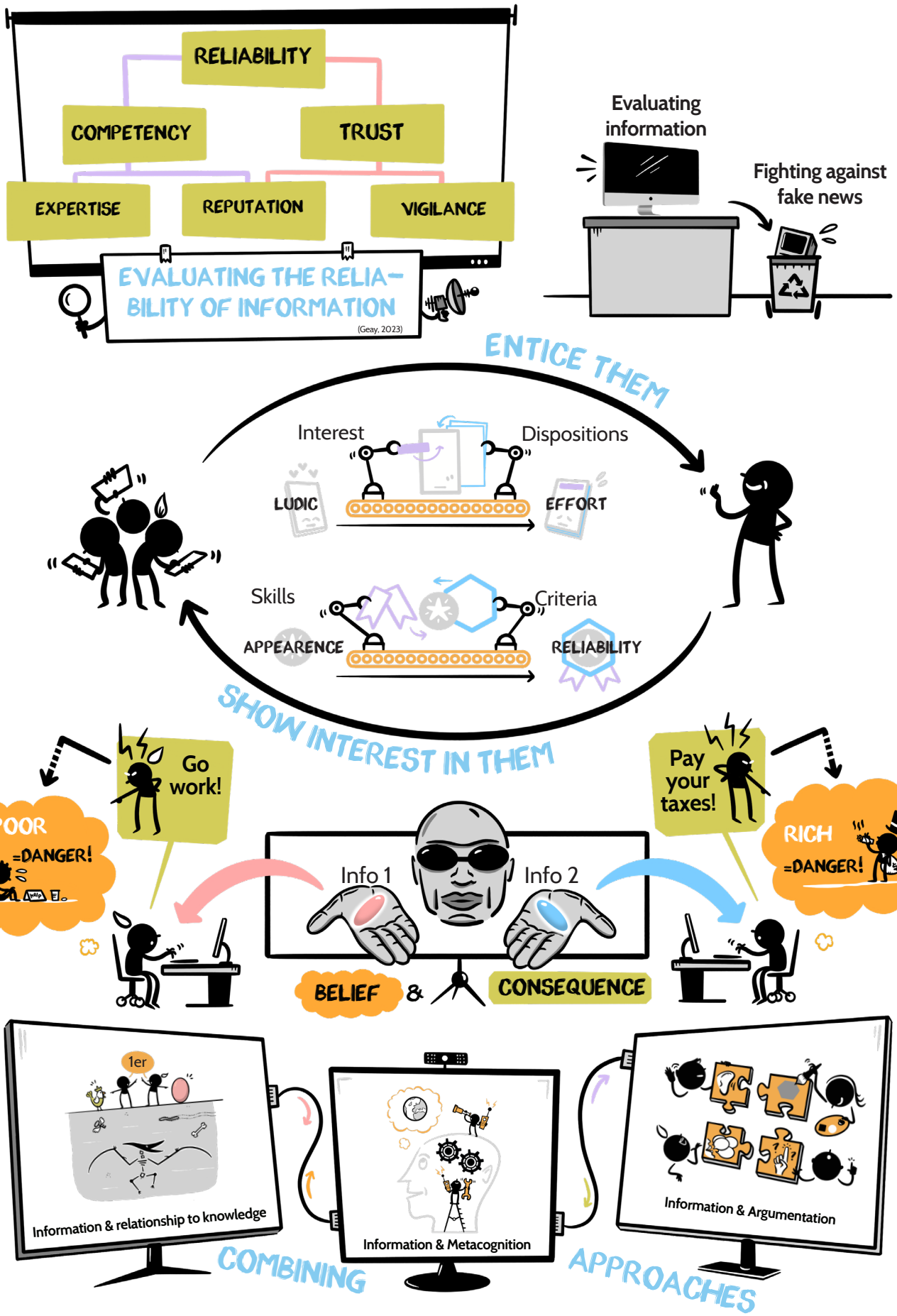
Would changing my stance relative to the pupils and their relationship to knowledge help motivate them to seek out information outside of class?

What media literacy resources do I use and how can I make use of them consistently with scientific research on information research and evaluation?

How can I work on information evaluation while transmitting a relationship to knowledge conducive to critical approaches?

How can I lead pupils to a metacognitive questioning on their information evaluation practices that has meaning for them?

How can I make students want to search for information, and engage in analysis when it is important to do so rather than reinforcing their distrust?



INFORMATION EVALUATION

Conclusion: fostering engagement in critical approaches across different contexts

Helping students to develop critical approaches in a school context, and perhaps outside of it, is an important objective but its complexity can be intimidating, especially in a restricted professional context (heavy curricula, lack of time, etc.). Many teachers have found ways to compromise, for example: by focusing on teaching curriculum content, hoping to sprinkle in elements conducive to pupils developing certain critical approaches related to their lessons; relying on institutional resources (e.g. CLEMI, CANOPÉ, CSEN in France), or ones from associations or developed by colleagues; developing their own teaching methods for critical approaches, based on their professional experience.

We feel traditional approaches to critical thinking education frequently come up against three pitfalls, and we will outline the precautions we took in creating this resource to avoid each of them.

A conceptual problem

The manner in which critical thinking and the teaching interventions to be implemented are conceptualised is often implicit and/or inconsistent, which is to say that the view of critical thinking that underlies teaching interventions often remains vague, and contradictions often emerge between the teaching stance, the content covered and the didactic and pedagogical choices made.

We chose to clarify the concept of critical approaches and to split the avenues for teaching into four broad axes: Relationships to Knowledge, Metacognition, Argumentation, Information evaluation. For each we mentioned a common teaching approach which might be limited or sometimes counterproductive, but we always provided an alternative supported by scientific research to ensure the criticism remains constructive.

Instead of limiting the definition of critical thinking, we opted to preserve some complexity, but also wanted to keep in mind the practical limitations of teaching. Hence why each section can be developed alone, though it is clearly more useful to work on them jointly, while gradually collaborating with colleagues or gaining proficiency in parts of critical approaches education.

The collaborative process that led to creating this resource, bringing together researchers from various fields among others, seems to be conducive to avoiding any inconsistencies or blind spots.

An assessment problem

Teaching interventions - even when a significant conceptualisation effort may have been made - are rarely thought of with predefined learning objectives in order to be able to assess the effect of these interventions. Scientific studies such as the meta-analysis led by Abrami and his colleagues (2015) highlight the great potential of approaches combining dialogue, instruction centred on practical problems, and mentoring.

On the other hand, scientific studies assessing the effect of critical thinking education are largely focused on practices aiming to develop skills, not dispositions (Abrami et al. 2015; Puig et al., 2019), and the assessment tools are very limited (Ku, 2009; Lai, 2011, Rear, 2019). However, we feel that working on dispositions is of particular importance.

Yet when it comes to assessment in various contexts, studies rarely offer teachers a way of easily collecting data which would allow them to most objectively estimate the effects of their interventions themselves, without involving researchers.

To cater to this need, we suggest to teachers as well as researchers, along with other members of the educational community, to collaborate in describing Challenges and Actions such as those that have served as practical examples within this resource. This is the product of work led by the Teachers as Researchers community dedicated to critical thinking education, hosted by the ÉPhiScience association.

One of the aims of describing the teaching Challenges encountered is specifically to define metrics for progress, or observable "building blocks", or data to be recorded, which will make it possible to demonstrate progress (or lack thereof) in achieving the goals of the Challenge and improvements to the problematic situation. These metrics, this data jointly created with teachers in order to be feasibly collectable, opens practical common avenues to analysing the effect of teaching practices on critical approaches.

At www.profschercheurs.org (FR) you will find all the information you need to join the Teachers as Researchers community and work together to find out

how to assess the effect of your Actions in meeting your many Challenges.

A collective problem

Critical thinking has been conceptualised as a characteristic of an individual person (more or less critically). However, a single situation can lend itself to multiple critical approaches, highlighting that there are several distinct dimensions depending on a person's knowledge and skills. Moreover, the concept of critical approaches opens the door to considering the group as the relevant analytical unit to judge, for example, a more or less critical decision.

Furthermore, critical thinking education practices are often isolated initiatives rather than the collective or collaborative movement we feel is yet necessary to foster engagement in critical approaches across different contexts. It is likely that the most durable and broad effects will be the result of joint actions aiming to support pupils in engaging in critical approaches across different contexts, repeated in various environments thanks to institutional support for example.

We hope this resource can help you build bridges with colleagues and management in order to obtain the widest support possible for your practice in teaching for critical approaches.

Global view: bringing together the different parts of this resource

Bringing together the four axes presented here could require more time and work, but not necessarily! Here we highlight some ways you could make the connection between the four axes of critical approaches education.

We feel that pupils' relationship to knowledge and metacognition could be interesting to develop via a learning activity on argumentation or on information research and evaluation.

We think honesty and intellectual humility are dispositions that reflect a relationship to knowledge conducive to critical approaches. We encourage teachers to adopt a stance that models these dispositions to pupils as much as possible. This could be by clearly expressing their desire to use the most reliable information possible in class, while also showing the limits of their knowledge and keeping an open mind when faced with uncertainty.

Other dispositions teachers might model through their teaching stance

could show their relationship to questioning and being challenged, as well as their desire to engage in argumentation in order to justify particular choices. For example, when confronted with pupils who challenge elements of the lesson, supporting them in improving their argumentation even if it aims to criticise certain aspects of the lesson could have a positive impact on both their dispositions and skills relevant to engaging in critical approaches.

We feel it is important to be accepting and considerate of the emotional aspects of the changes we expect in students along each of the four axes. An evolving relationship to knowledge, metacognition seen primarily as a disposition, growing motivation to seek out and evaluate information or to engage in argumentation, all of this includes a major emotional dimension. We thus consider it important to not neglect the privileged, trusting relationship you can develop with your pupils.

A general recommendation you will find in various parts of this synthesis is to clearly communicate expected behaviours and to praise them. This requires a good understanding of the potential expressions of these dispositions, and stakes for engaging in critical approaches that might underlie them.

Of course, working on one's own dispositions and teaching stance is not straightforward. Doing so is "taking a risk" in that it might feel like a waste of time given busy curricula, or when such change means things do not progress as expected. Likewise, we can imagine that when we ask pupils to make similar efforts for information evaluation or argumentation, they also feel like this is a lot of effort for insufficient reward. We hope to have given you elements in this resource that justify the value of "taking this risk", both for yourself and for your students.

However, the individual work you might accomplish on your stance or your teaching choices will, in principle, not be sufficient, which is both good and bad news. Good news as everything does not rest on your shoulders: be as kind to yourself as you can, teaching critical approaches is complex and demanding, and it is impossible to do everything alone. The bad news is that depending on your situation, it might be difficult to move forward together with your colleagues.

Ideally, if pupils were faced with several teachers whose stances model desirable dispositions for critical approaches, this would further encourage their

engagement with critical approaches across different contexts. Should you not be able to find support locally, we can only encourage you to join the Teachers as Researchers community dedicated to critical thinking. Even if the colleagues you will find there are not dealing with the same pupils, feeling alone is detrimental to anyone's motivation, and a breath of fresh air can sometimes make all the difference in our ability to support pupils.

The limits of this resource and additional elements

We believe this resource could significantly contribute to taking on the challenges and avoiding the pitfalls mentioned previously, but a certain number of limits remain. We do not have the power to change institutional frameworks, to rework the curriculum or to reorganise your school, but we can however offer you some help in getting the most out of this resource.

First of all, along with possibly contributing to your professional development, the scientific studies reporting promising avenues to help teachers make use of research (see for example Rycroft-Smith, 2022) includes different forms of guidance. If you wish to train yourself or provide training to teachers on the basis of this resource, you can write to pleen@ephiscience.org for more information on what might meet your needs.

Another limit of this resource is a lack of clear and systematic links between the concepts used, possible teaching interventions and the curriculum. A future update to this resource will aim to clarify these curricular links and increase the number of practical teaching activities as well as detail their effects, based on certain metrics.

An additional limit is that this resource does not directly indicate the norms and criteria underlying our concept of critical approaches, but instead communicates them indirectly via the production of Challenges and Actions within the Teachers as Researchers community for critical approaches education.

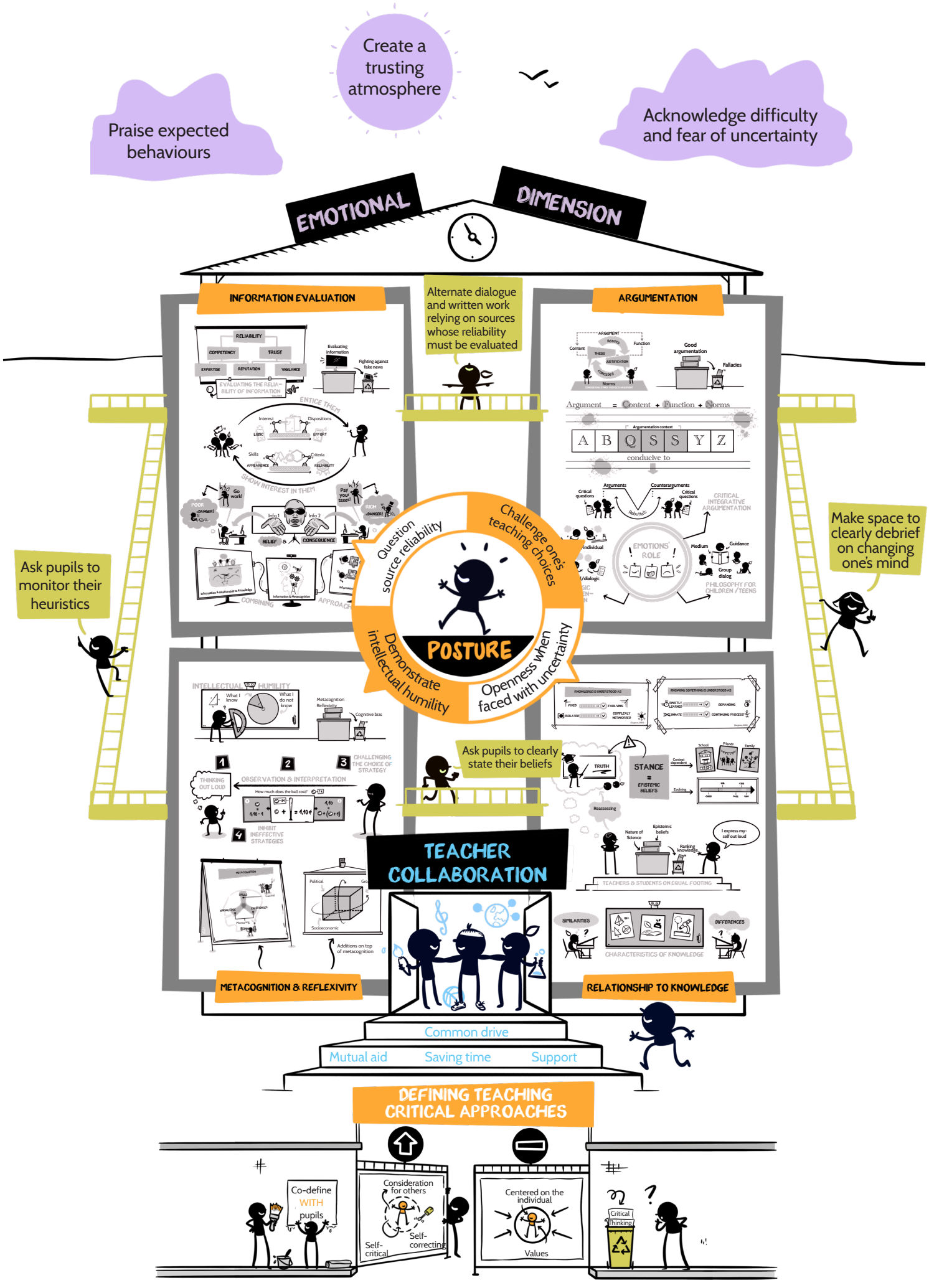
We must also mention a possible involuntary slant of this resource in favour of secondary, rather than primary school teaching. While the initial intent of this resource was to be relevant to all school levels, it so happens that of the teachers who contributed to improving it, most teach in secondary school.

As a result, it is possible that its content might seem directed primarily to secondary teachers. If this is indeed the case, we will work to make this resource more inclusive in the future. Similarly, the contributing teachers all work within the French school system. It is an open question to what extent the ideas developed herein are adapted to other countries, but we remain committed to an inclusive approach and encourage colleagues in other countries to make use of this resource, adapting it as and where needed, depending on the local teaching context.

Final words

More than three years after the first version of this resource, major changes were implemented to take account of scientific research into helping teachers make use of research, and to widen the range of studies on critical thinking education. It is the result of "oriented research through conception", a type of collaborative research characterised by an iterative dimension: this means that it will continue to improve, and other versions will eventually be created.

If you would like to contribute in some way to the future development of this resource, do not hesitate to indicate your interest to pleen@ephiscience.org. My deepest thanks to all those who have already contributed, as well as to those who will contribute in the future.


Create a trusting atmosphere
Praise expected behaviours
Acknowledge difficulty and fear of uncertainty
EMOTIONAL DIMENSION
INFORMATION EVALUATION
Alternate dialogue and written work relying on sources whose reliability must be evaluated
ARGUMENTATION
Ask pupils to monitor their heuristics
Make space to clearly debrief on changing one's mind
Question source reliability
Challenge one's teaching choices
POSTURE
Demonstrate intellectual humility
Openness when faced with uncertainty
Ask pupils to clearly state their beliefs
TEACHER COLLABORATION
METACOGNITION & REFLEXIVITY
RELATIONSHIP TO KNOWLEDGE
Common drive
Mutual aid
Saving time
Support
DEFINING TEACHING CRITICAL APPROACHES
Co-define WITH pupils
Consideration for others
Self-critical
Self-correcting
Centered on the individual
Values
Critical Thinking

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Conclusion

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Glossary

Argument: The content of an argument is split into several parts, implicit or explicit: a thesis, which is the proposition we hold to be true, corresponds to a person's viewpoint on a topic. To form a good argument, this thesis must be supported by a justification which can be variably robust, or easy to rebut, depending on several criteria such as its validity domain, that is to say the broad context within which this justification is valid. An argument can then play various roles in a dialogue, for instance introducing a new idea, or nuancing an element from a previous argument.

Argument from authority: Argument which aims to justify the supported thesis on the basis of a claim to the legitimate authority (e.g. scientific, coercive, statutory, etc.) of a given source of information.

Critical approaches: Critical approaches represent an alternative to the concept of critical thinking. They require harnessing dispositions, skills and knowledge by coupling reflection and action in order to answer questions on what to believe or what to do. We can consider them both at the group and the individual level, and they can take a variety of forms depending on the context and the characteristics of the given group/individual.

Critical integrative argumentation: Nussbaum describes the integrative dimension as being the integration of counter-arguments and their refutations. The critical dimension refers to critical questions we must ask in order to assess the persuasive strength and robustness of the arguments and which aim to make the dialogue more complex and subtle. Critical integrative argumentation includes an assessment of the cost and benefits of different positions, and where relevant takes into account the body of evidence in favour of a model and alternative models which account for several factors and constraints.

Dispositions: Related to the concepts of virtues, attitudes or stances, or even of habitus, they refer to a recurring way of acting when confronted to a family of similar situations (Lange, 2014). While we might compare them to personality traits, they are differentiated by the fact that they no longer manifest (or in a different way) as soon as the context changes.

Education for: Grouping of education objects with a common cross-disciplinary and normative dimension on social issues.

Epistemic beliefs: Several concepts from parallel studies relate to beliefs individuals have on the nature of knowledge and the act of knowing. We will use the term epistemic beliefs, but for a detailed description of the different approaches, we refer you to De Checchi (2021).

Fallacies: Fallacies are generally arguments that appear correct or convincing, but are incorrect logically or epistemologically (Pallares, 2019). This can be due to errors (paralogisms) or an intent to mislead (sophism). This concept emerges from research on informal logic whose consensus seems to be that one must study arguments case by case, and that there is no absolute rule to identify a given argument as fallacious, which complicates their recognition.

Intellectual humility: Though there is no consensual definition, we can consider it a trait that is considered desirable which include a recognition of one's intellectual limits and an appreciation of justified conflicting opinions.

Knowledge: Knowledge is a necessary internal resource to engaging in critical approaches. It comes in several forms, such as "subject" knowledge or "declarative" meta-knowledge, such as knowledge on what critical approaches are and how to harness them.

Metacognition: Metacognition is often understood as thoughts on one's thinking, or reflection about one's reflection. It is a combination of knowledge (of one's cognition and that of others), experiences (feelings and judgements related to one's cognition), and skills (strategies implemented to control one's cognitive activities).

Mobilisation across different contexts: This notion emphasises that different individuals could apply a skill in different ways in different situations, each specific and requiring different knowledge. We favour this concept over that of "transfer", in line with researchers such as Gagnon (2008). Indeed, the metaphor of the transfer, seen as a type of "copy-paste" between more or less similar situations, is misleading as to the nature of the learning that occurs. On the contrary, by speaking of mobilisation across different contexts, we highlight the specificities of the action in a given situation, and particularly of the specificities in each subject area. This avoids suggesting that developing critical thinking is the prerogative of a given discipline, with a transfer to other fields subsequently taking place.

Nature of Science: This concept emerges from the philosophy of science, and refers to the characteristics of scientific knowledge. We broaden its use to also include the manner in which this knowledge is produced (scientific inquiry) following the work of Bächtold et al. (2021) among teachers in France showing links between the two.

Norm: Set of criteria (not necessarily explicit) that are meant to be shared, relating to what is judged as good or desirable.

Reflexivity: We consider reflexivity as a "complex process which takes place on multiple levels" (Couturier, 2013, p. 12). It also contains a consideration of reflection about reflection as with metacognition, but goes beyond it since "it is not centred on the individual and their affects but places the relationship between the structural and the individual as a central aspect of reflection." (ibid., p.13). Thus reflexivity in its complexity includes a reflection on the social conditions and influences of our reflection, not simply limited to answering "what do I think?" but also "why do I think that?".

Science: We include here a wide range of fields of academic research, not only experimental sciences but also the humanities, social sciences, history, geography, linguistics, etc. However, experimental sciences enjoy a greater prestige, and the knowledge they produce is often seen as more reliable, even when this is not justified.

Scientific inquiry: There exists a wide range of definitions for scientific inquiry (Hasni et al., 2018). These include common elements with critical approaches such as formulating questions and problematization or analysing and interpreting data. It also holds an important warning: do not define it as a series of linear steps to be applied by pupils.

Skills: We can see them as know-how for complex situations, requiring dispositions to put the skill into practice by relying on a range of knowledge or other internal and external resources (drawn from Gagnon, 2008).

Socialisation: All the transformations an individual goes through due to society as a whole, expressed as ways of thinking or acting that are socially situated (Darmon, 2016).

Socioscientific issues: Socioscientific issues are characterised by their topics related to society, at a local or broader level, and that they involve

sciences and/or current or emerging technologies (Pallares, 2019, p. 73). They are thus complex, marked by uncertainty and open. They are different from academic problems for which teachers can provide simple and unequivocal answers. Socioscientific issues are subject to debate and disagreements, and call for nuance in any assertions.

Theory of mind: Theory of mind is a concept developed in psychology which characterises the ability a person has to reliably envision the content of someone else's mind. Specifically, it implies the ability to understand the beliefs and viewpoint of another.