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Citizen science to engage educators in the production of structured practice-based evidence at a large-scale

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All Figures and Tables are available at the end of the manuscript.

Supplementary Information is available here: <https://osf.io/vf6ar>

Abstract

Background: Every day, millions of educators try out new practices to improve education. If a small proportion of them made the observed effects of their practices publicly available in a database of *practice-based evidence*, this could become a promising source of information for other educators to better judge whether new practices are worth the try in their own context. However, engaging educators in producing trustworthy practice-based evidence and organising such a database so that others may easily find relevant cases is challenging.

Objectives: We aimed at engaging educators in the production and publication of practice-based evidence that is trustworthy, accessible and organised in a structured and easy to query database.

Methods: We developed the “Teachers as Researchers” (TaR) programme, a citizen science project to promote the publication of the results of educator-led collaborative research at a large scale. We trained volunteers to create communities of educators and to facilitate workshops for their communities. During workshops, community members are guided to describe shared educational Challenges and possible Actions to address them. Then, educators implement the Actions and collect contextualised evidence attesting for the evolution of their Challenge. Back to workshops, educators are guided to produce Feedback reports in which they report evidence about the capacity of the Action to address the Challenge in their specific contexts. Once several educators have provided Feedback for the same Action, educators produce Syntheses to compare the evidence across contexts. Each of these steps results in collaboratively written documents published in a common publication platform which incorporates a peer-review system for educators to improve each others’ writings. In the platform, educators can navigate across existing Challenges, allowing different communities to coordinate their efforts towards a Challenge by mutualizing their Actions and Feedback. We report here a description of the implementation of the TaR programme in France during its first academic year, 2020-2021.

Results: During 2020-2021, the research team and 14 trained facilitators created 10 communities that collectively recruited 168 educators from primary school to higher education, including teachers, trainers, principals and researchers. Communities were created for a large variety of reasons: addressing the challenges shared in a school, of teaching a specific discipline, around a common theme of interest, or of a specific professional role. Communities offered a total of 118 workshops. Sixty Challenges were initiated, to inquiry about practices supporting students’ development within and outside educational institutions, as well as practices supporting educational institutions through professional development and school management. We highlighted one Challenge entitled “How to help a disruptive student control his or her violent outbursts?”, which received the highest input during the study period. Eighteen educators with a wide range

of roles and from different geographical areas joined at least one of the 23 workshops addressing this Challenge. Three different Actions and four related Feedback were published and peer-reviewed.

Conclusions: We developed a citizen science project that engaged a high number of educators in a collective research enterprise about their practices. It engaged educators for a wide range of reasons, from a wide range of sectors and contexts, and confronted with a wide range of educational concerns. It allowed the production and publication of contextualised practice-based evidence from different educators experimenting the same practices towards common goals. The implementation in this first year suggests the TaR programme produces meaningful practice-based evidence, is robust, adaptable, engaging, and scalable.

Keywords: citizen science, practice-based evidence, collective intelligence, teachers' professional development, reflexivity, teacher communities, participatory research.

Introduction

Despite being in different contexts, educators all over the world face demanding responsibilities and similar challenges. Teachers must deal with what Kennedy (2016) called the “five persistent challenges” of teaching: how to portray the curriculum, enlist student participation, expose student thinking, contain student behaviour, and all this while accommodating their own personal needs? While teachers may be “the single most important school variable influencing student achievement” (McKenzie et al., 2005), other stakeholders also play important roles in supporting schools and their students. Principals act upon their institution’s organisation, district managers coordinate teaching resources, teacher trainers offer professional development activities, policy makers launch new reforms, and parents find new ways to support their children. For simplicity, we use the term 'educator' throughout to refer to any stakeholder in education regardless of their precise role, from early childhood to adult learning.

Every day, educators make decisions to address the educational challenges based on a variety of sources such as conversations with colleagues, blogs, pre-service and in-service training, governmental directives, research results, as well as their own past experiences. However, the information obtained from these sources may be untrustworthy (e.g. not supported by evidence), irrelevant (e.g. unrelated to the educator’s context), or inaccessible (e.g. obscured by academic jargon). Information from different sources may also contradict each other. As an example, a teacher may believe that differentiating teaching according to students’ perceived ‘learning styles’ is effective and recommend it to their colleagues, whereas academic research provides robust evidence that this is not the case (Cuevas, 2015).

The evidence-based education movement suggests that educators can improve their decisions based on evidence produced in systematic, critical, and transparent research settings (Davies, 1999). In the past decades, educational researchers and policy makers have put a strong focus on the conduct of randomised controlled trials (RCTs), considered by many as the ‘gold standard’ in evidence production (Connolly et al., 2018; Hedges & Schauer, 2018; Torgerson & Torgerson, 2001). However, a persistent gap exists between outcomes from RCTs suggesting effective practices and their use by practitioners. One reason may be that recommendations emerging from research conducted in such controlled settings are often unrelated to the real-life contexts in which educators work (Dagenais et al., 2012; Harrison & McCaig, 2017). Also, in RCTs researchers need to narrow down the educational objectives of the interventions

under study (e.g. through the use of standardised tests as primary measures to evaluate effectiveness), possibly leaving aside goals and values important to educators (Biesta, 2010). Furthermore, prescribing standardised practices issued from research may go against a vision of educators as “active agents of improvement rather than [...] passive receivers of knowledge developed by others” (Bryk, 2015, p469).

Other researchers argue that educators themselves can produce relevant evidence about ‘what works in their context’ based on the observation and analysis of their own practices. The term *practice-based evidence* emphasises practitioners’ capability to surpass the shortcomings of generic research-based ‘what works’ recommendations as they themselves can obtain and contrast evidence about the efficacy of different practices in different contexts (Green, 2008). Practitioners are not expected to control the messy unpredictability of the real world when analysing their own practices, but could still report case studies that are rich in detail, concrete, and highly contextualised. A database of practice-based evidence in the form of a collection of case studies could potentially become a knowledge base for educators providing narratives of past (positive or negative) experimentations that are actionable and tailored to concrete educational contexts (Hiebert et al., 2002). Such a knowledge base would not lead to generalisable normative recommendations, but rather help educators to better judge whether a practice is worthy to be implemented in their context (Biesta, 2010; Dupriez & Cattonar, 2018). It could also help educators and researchers identify patterns across case studies to gain a better understanding about educational practices and their impact, as suggested in psychotherapy research (D. B. Fishman, 2005; Iwakabe & Gazzola, 2009).

The shortcomings of practice-based evidence

Building a knowledge base from practice-based evidence in education is not straightforward. We will present some shortcomings related both to the production of practice-based evidence and to its potential use as a knowledge base, as well as possible ways to deal with them.

The first shortcoming is related to the *quality* (or internal validity) of evidence when it is produced by practitioners themselves. If a systematic protocol for implementing a practice and observing its results is not followed, or if the educators’ prior beliefs go unexamined, the evidence will be less reliable and trustworthy as compared to evidence from highly controlled studies. To increase evidence quality, educators could apply research principles to plan, record and analyse observations about their practices,

as done through action research (Cohen et al., 2017a), or more sophisticated single-case experimental designs (Plavnick & Ferreri, 2013). They could also involve external educators in different steps of their inquiry to decrease their own biases, or could receive help and guidance from researchers (Coburn et al., 2013).

The second shortcoming is about the *transferability* (or external validity) of practice-based evidence. If the conclusions are too dependent on the original context of the case study, it may be hard to transfer any gained insights to other contexts. Thus, while the reports must be rich in detail to ensure readers understand what was done, they would also need to clarify how the reported practice may be implemented elsewhere and discuss the main factors affecting its implementation (Humphrey et al., 2016).

The third shortcoming is about *accessibility*. If high-quality case studies exist but are hard to find or to understand, others will not benefit from them. Thus, the reports must be intelligible, stored in user-friendly databases, and publicly shared (Hiebert et al., 2002).

But compiling a collection of case studies is not enough. Educators must be able to navigate the database to decide what is meaningful to be examined (Hiebert et al., 2002; Iwakabe & Gazzola, 2009). The fourth shortcoming is thus the *identification of relevant cases*. What counts as 'relevant' depends on the specific concerns and context of the educator looking for insights. For example, educators may wish to find evidence about a specific challenging situation they are facing or about a specific practice they want to try with a specific age group, discipline, socio-economic context, and so on. To solve this, the collection of case studies would need an indexing system that accounts for the inherent multidimensionality of educational goals, practices and systems.

To improve the quality, transferability, and accessibility of case studies, and facilitate their identification, educators might benefit from following reporting guidelines. By doing so, they would provide the minimal information required for others to understand the context, methods and results of their case study. In the medical sciences, guidelines exist for case reports (Gagnier et al., 2013) and other research methods (Simera et al., 2010), and compliance with such guidelines is considered as one of the main solutions "to increase value and reduce waste in biomedical research" (Macleod et al., 2014, p104).

The fifth shortcoming, related to the previous one, is related to the *massive number of case studies* that would be needed for any external educator querying such a database to find a relevant case. Such a database may be more valuable if it included not only one but different points of views for the same object

under study. For instance, an educator may gain deep insight if she read several (and potentially contradictory) case studies for a situation of interest, or even a synthesis of them, e.g. in the form of a meta-analysis or a meta-synthesis (Iwakabe & Gazzola, 2009; Nye et al., 2016). Collecting such a high number of case studies may sound unrealistic, but the potential exists: in France, where the project reported here is based, there are about 1.2 million educators in primary and secondary schools alone (Direction de l'évaluation, de la prospective et de la performance, 2021). Even if a small proportion of these educators shared their practice-based evidence, this would sum up to a considerable number of cases, and may treat a sufficiently dense amount of educational aims, practices and contexts.

The sixth and overarching shortcoming is *engagement*. Conducting systematic inquiries about one's own practices and writing reports about them may be a burden for educators that often lack time and incentives to engage effort to fulfil such activities (Cochran-Smith & Lytle, 1990). The large amount of case studies needed calls for the engagement of a large number of educators. Furthermore, educators should be engaged not only in the production of practice-based evidence, but also in the use of evidence created by others. The right guidance, support and incentive structures are thus needed.

Existing frameworks partially addressing these shortcomings

Several frameworks have been developed to guide educators to reflect about, experiment with, and change, their practice, with the potential to produce high-quality practice-based evidence. Some examples are reflexive practitioner (Dana, 2014), practitioner inquiry (Cochran-Smith & Lytle, 2009), collaborative inquiry (DeLuca et al., 2015), professional learning communities (DuFour, 2004), and communities of practice (Wenger, 2000). Often these are framed as professional development (PD) activities, i.e. “structured, facilitated activities for teachers intended to increase their teaching ability” (Sims et al., 2021, p7). As a side effect, PD activities often produce records of practice and of their impact on students (e.g. video recordings, teacher narratives, or analyses of students' work). Such records, if compliant with reporting guidelines, made public, and indexed, could be a valuable source of practice-based evidence. Unfortunately, PD activities generally do not produce records with all these properties as their main objective is promoting local positive change in practices rather than producing a shareable knowledge base. We focus here on three frameworks that deal, to some extent, with the shortcomings listed above: *Lesson Studies*, *Networked Improvement Communities*, and *Scholarship of Teaching and Learning*.

Lesson Studies (LS) is a form of PD in which teachers create small groups to collaboratively plan, implement, observe and reflect about a specific lesson under study (Lewis et al., 2004). Hiebert et al. (2002, p9) said that “to build a professional knowledge base for teaching from practitioner knowledge”, LS is “one of the only large-scale systems we are aware of that intentionally facilitates this kind of transformation”. In LS, teachers produce written reports with the details about the lesson implemented, the observations, and their reflections. The World Association of Lesson Studies lists national LS initiatives across the globe, with templates to guide teachers in writing their reports (*Related Websites – WALIS*, n.d.). In Japan where LS originated and are widely implemented, LS reports are stored locally, but could also be published and found in bookstores. To our knowledge, a scarce number of English (or French) LS reports are publicly accessible in electronic databases as compared to the large number of teachers involved in LS around the world. For instance, the database created by the Lesson Study Alliance, the main organisation promoting LS in the US, included only 39 reports for the 2005-2022 period (“Lesson Study Resources,” 2015).

Networked Improvement Communities (NICs) are social organisations involving practitioners, decision makers, researchers, and designers in the design, testing and further improvement of local and contextualised solutions to the implementation of educational reforms (Bryk, 2015). In his 2014 AERA distinguished lecture, Anthony Bryk (ibid. p469) defines NICs’s aim as “building practice-based evidence”. Knowledge management (e.g. how the practice-based evidence is spread and reused across the network) is crucial to the initiation of NICs, in particular when the number of actors testing solutions locally grows (Russell et al., 2017). Some guidelines exist for educators involved in NICs to produce reports of practice-based evidence for internal use within the NIC (Park & Takahashi, 2013). As NICs are mostly used as means to scale and sustain educational reforms (B. J. Fishman et al., 2013; Joshi et al., 2021), their publications generally concern the results of the overall implementation of the reform (Feygin et al., 2020) and not the individual pieces of practice-based evidence created by educators as they continuously improved its local implementation. The practice-based evidence created in a NIC could be of great value outside the NIC itself as it may illustrate practices also relevant outside the implementation of the specific educational reform (e.g. coordination of the pedagogical staff, or classroom management to adapt practices).

In higher education, under the name of *Scholarship of Teaching and Learning* (SoTL), university lecturers are invited to “collect and present rigorous evidence of [the] effectiveness” of their teaching practices (Trigwell et al., 2000, p156). In addition to providing a framework for practice-based inquiry, the SoTL movement provides scholars with platforms to communicate their research to “improve student learning generally” (i.e. beyond their individual contexts) (*ibid*). Peer-reviewed academic journals such as the *International Journal for the Scholarship of Teaching & Learning*, the *Journal of the Scholarship of Teaching and Learning*, or *Teaching & Learning Inquiry*, allow scholars to publish their practice-based inquiries as scientific articles. To our knowledge none of these journals explicitly ask authors to comply with reporting guidelines to facilitate comparisons across studies, as largely done in medical journals (*ICMJE Recommendations*, n.d.). Furthermore, analysis of citation practices in SoTL suggest that SoTL authors do not substantively base their work on each others’ (Cappello & Miller-Young, 2020). While engaging scholars in SoTL is challenging (Chalmers, 2011; Happel & Song, 2020), they may need little guidance in following research protocols and writing scientific reports even in a domain (education) that is far away from their original one, and publishing scientific articles remains a natural incentive to them. This may be less the case in other educational sectors such as primary and secondary school, for which adapted guidance to scientific practices and adapted incentives would be required.

In summary, if trustworthy, accessible, and organised in a structured and easy to query database, practice-based evidence could become a promising source of information to help educators identify what could work best in their context. Several frameworks exist to guide educators in the creation of high quality reports about their practices, but rare are the examples that have integrated the publication of such reports to help others inform their practices. The value of such a database would increase if a high number of educators were engaged in its creation and update.

This study

To this aim, we have designed the ‘Teachers as Researchers’ (TaR) programme (‘Programme Profs-Chercheurs’ in French). Its main goal is to engage a large number of educators to produce concrete, rich and contextualised practice-based evidence that is trustworthy, published in an openly accessible database, and organised in a way that allows practitioners to query it, find relevant work, compare the evidence, and identify what practice could better work for them. The term ‘teachers’ in the TaR programme

is synecdochic referring not only to those who teach directly but to all educators. The term ‘researchers’ is meant to characterise “educators as active inquirers [...] bound together by norms and structures akin to a scientific community” (Bryk, 2015, p469).

The TaR programme is designed as a *citizen science* project (also known as *public participation in scientific research*). In citizen science projects, researchers from diverse fields such as astronomy, biology or ecology design methods and tools to increasingly engage members of the public in research (Shirk et al., 2012). The public may be involved not only in the collection of data following protocols defined by researchers, but also in the definition of research questions, methods, data analysis and reporting, generating new science-based knowledge difficult or impossible to reach by small teams of academic researchers (Haklay et al., 2021; Skarlatidou & Haklay, 2021). Within the TaR programme, educators contribute to a collective research effort by inquiring about their practices. Viewed as a citizen science project, the focus is on the capacity of the TaR programme to engage educators in producing scientific knowledge from their practice-based inquiries. The TaR programme can also be viewed as a PD activity aiming to improve educational practice. Another article from our team focuses on this specific point (Pagnotta et al., 2022). Furthermore, the TaR programme could be viewed through the lenses of the emerging field of *collective intelligence*, investigating how best to find collective solutions to collective educational problems (Mulgan, 2018).

This article has two aims. The first is to describe the TaR programme in detail such that others may adopt or adapt it. The second aim is to report the results of its implementation in France during the academic year 2020-2021, attesting to its potential to engage educators in the creation of a knowledge base for educators grounded on practice-based evidence. Finally, we discuss how the features of the TaR programme address the different shortcomings listed above.

The “Teachers as Researchers” programme

In a nutshell, the programme trains volunteer educators to create communities – TaR communities – and to facilitate regular workshops in which community members follow a methodology – the TaR methodology – designed to motivate collaboration and reflection about their practices while at the same time producing structured records of practice-based evidence. The work of TaR communities is undertaken in a collaborative publication platform to promote wide collaboration across communities and to feed a shared and public database of practice-based evidence.

The “Teachers as Researchers” methodology

The TaR methodology reflects an idealised model of scientific inquiry for practitioners. It is structured around four activities in which educators collaboratively produce four types of written objects we respectively call Challenges, Actions, Feedback, and Syntheses (See Figure 1, for clarity, we capitalise the terms when referring to these objects). Each object has a dedicated template to ensure complete reporting (See Appendix S1).

In the first activity, educators identify specific Challenges they want to address from the background of their concerns. Challenges are titled as research questions of the type ‘*How to [attain an objective]?*’. For example: ‘*How to help students become autonomous in their learning?*’; or: ‘*How to improve collaboration among teachers within the school?*’. A Challenge description should provide sufficient details about the situation of concern while remaining general enough to be relevant to educators in different contexts.

In the second activity, educators identify practice-based hypotheses called Actions, corresponding to concrete strategies that could be implemented to overcome a Challenge. Ideas for Actions may come from different sources including personal experience, suggestions from colleagues, and research literature. For each Challenge, educators may identify several independent, but potentially complementary Actions. For example, to address the Challenge ‘*How to improve collaboration among students?*’, an Action may be ‘*Implementing tutoring between peers*’, and another may be ‘*Assigning specific roles to students during group activities*’. An Action description should provide sufficient details about the resources and steps for others to understand its implementation, and should also be general enough to allow educators from different contexts to implement it.

In the third activity, educators prepare and implement an Action, observe the evolution of their challenging situation, and share written Feedback in which they report evidence about the capacity of the Action to address (or not) the Challenge in their specific contexts. While Challenges and Actions may be shared between educators working in different contexts, each Feedback reports a single Action implementation and is therefore always context-specific. In other terms, Feedback objects are Challenge-oriented case studies reporting the results of Actions implemented in a specific context. Each Action may have multiple Feedback, one for each instance of implementation. For example, two educators in different contexts (e.g. in different geographical areas, in public vs private institutions, in primary vs secondary school) facing the same Challenge *'How to improve collaboration among students?'* and testing the same Action *'Implementing tutoring between peers'* may provide each their context-specific Feedback. In one case the Feedback may be overall positive, while in the other not. The content of the Feedback is intended to provide enough details to understand the context, how the Action was implemented, and how the Challenge evolved. Educators are also invited to provide an overall assessment about whether the Action helped address the Challenge, on a 5-point scale with anchors "the situation worsened", "not at all", "a little", "sufficiently" and "totally". Before implementing their Action, educators can follow a dedicated guide (see Appendix S2) to design experimental protocols and observation tools to increase the systematicity of their inquiry. The more basic example is to predefine a set of (quantitative or qualitative) variables to capture the state of the challenging situation and details in action implementation, and a set of time-points to conduct repeated observations (e.g. before, during and after Action implementation). The result is a 'field notes' document that educators can use to record their observations by themselves or with the help of others whenever possible. Educators can use the recorded observations as supporting material in their Feedback.

In the fourth activity, educators systematically examine and summarise the results from multiple Feedback objects in a Synthesis to answer broad questions of interest (e.g. *'Is Action A able to address Challenge X across contexts?'* or *'How do the different Actions A1, A2,... compare in their ability to address Challenge X?'*). In addition, a peer-review system allows educators to help each other improve the overall quality and accessibility of their writings following activity-specific review prompts (Appendix S3).

Each Challenge inaugurates a collaborative research project to which any concerned educator can contribute over time. Individuals may contribute by coauthoring one (or several) of the possible written

objects issued from the activities. Some individuals may collaboratively identify a new Challenge. Others may describe one or more Actions to address it. Some time later, other educators may decide to implement an interesting Action and provide Feedback, even if they did not participate in the previous steps. Once there is sufficient Feedback, another group or individual may summarise the available evidence in a Synthesis. Although the activities are logically linked to form a research cycle, individuals themselves do not need to conduct all activities for a given cycle to be concluded. This relative independence of a research cycle from a specific set of individuals allows for the collective research to advance while allowing individuals to contribute according to their abilities, time, and interests.

The activities of the TaR methodology happen during workshops (usually 2 hours in length), in which dedicated facilitators organise the collective work of participants by creating subgroups and assigning them to activities of the TaR methodology according to their individual interests and concerns (e.g. following an initial round table). For example, a group of 2-4 educators may work on the description of a new Challenge, another may conduct the peer-review of an Action written by others during a previous workshop, and a last group may prepare their “field notes” for another Action. The facilitators explain and clarify the TaR methodology, provide access to the templates, keep the focus on the writing tasks (and not only verbal discussion), promote a supportive atmosphere for educators to openly share their concerns and practices, mediate conflicts, and manage time.

The “Teachers as Researchers” communities

The educators that join workshops and do the activities are organised in TaR communities. The research team trains and assists volunteer educators to create their own TaR communities and facilitate workshops (see Appendix S4). The facilitators are in charge of recruiting members and defining membership rules considering the concerns, job context, and roles of their (potential) members. For instance, some TaR communities could be open to all actors working in the same educational institution regardless of their topics of concern, while other communities could be open to actors interested in the same topic (e.g. maths teaching, school administration) even if they worked at different institutions. Facilitators are also in charge of defining a workshop schedule (which can be in-person or online), dealing with administrative needs such as finding institutional support for the community (e.g. counting the workshops as a PD activity), arranging the technological requirements, and running the workshops.

The “Teachers as Researchers” collaborative publication platform

We developed a collaborative publication platform (<https://plateforme.profschercheurs.org>) to support the work of TaR communities, mutualise their efforts, and build a centralised database of practice-based evidence. It includes a search engine and is designed to allow any interested educator to identify relevant pieces of practice-based evidence to inform their practices, once sufficient content is published. By navigating across published Challenges, educators may find one that captures their concern. By querying the corresponding Actions, they may find one that is similar to their current practice or one that would be easy to implement based on their available resources. They may find Feedback reports from one (or several) educators practising in contexts similar to theirs. Maybe a Synthesis of multiple Feedback objects was already conducted, providing them with a summary of the evidence.

TaR community members get a personal account which allows them to create new objects (Challenge, Action, Feedback or Synthesis), add other members as coauthors, and collaboratively describe these objects (following integrated templates) using text, images, videos, links, and documents. Coauthors can submit their objects to peer-review, reviewers can follow review prompts and share their report with coauthors, who can then improve their work. Drafts can be made visible for users with an account to avoid unnecessary efforts (e.g. duplicated Challenges) and encourage collaboration between TaR communities. Coauthors can ultimately make their work visible to the public.

Implementation of the “Teachers as Researchers” programme

We conducted an observational cohort study following the implementation of the TaR programme in France during its first year, from September 2020 to July 2021. We report examples of practice-based evidence produced, the characteristics of the TaR communities created, their members and their activities. In another article we reported the impact of the TaR programme on participants’ educational practice (Pagnotta et al., 2022).

Recruitment

The programme started with one TaR community: “*Les Mercredis du CRI*” run by the research team (see Appendix S5). Weekly on-line workshops started in October 2020 with participants recruited through

personal contacts, social media and word of mouth. Educators could come to these workshops at their own pace and at no cost to them. We also provided two online training sessions for educators interested in becoming facilitators in November 2020 and May 2021, at no cost to them. Trained facilitators coordinated their own recruitment efforts with our support. Educators joining a TaR community were invited to give consent to participate in this cohort study upon sign-up, but this was not a requirement to join a TaR community. Only TaR community members who gave consent were included in this study, and we refer to this subset as 'participants' hereafter.

Data collection

We collected participants' characteristics at sign-up using an online survey, including: gender; role in the educational system (primary or secondary school teacher; staff supporting teachers; researcher or university lecturer; other); years of experience in education; geographic location; type of educational institution (public or private); socio-economic status of their institution (deprived, privileged, or mixed); motivation to join the TaR programme (free text). Facilitators provided community-level characteristics including the focus of interest (if any) and the institutional support they received for the community activities (if any). Through a dedicated community management tool provided by the research team, facilitators recorded information about the workshops they conducted: date; format (in-person, online, mixed); attendees, and activities of the TaR methodology conducted. Finally, we obtained object-level characteristics from the collaborative publication platform, including coauthorship; written content; and peer-reviews.

Data analysis

We described the TaR communities, their members and activities, to demonstrate the capacity of the TaR programme to engage a large number of educators in the collective effort to produce a common database of practice-based evidence. We summarised the characteristics of TaR communities and participants, and retrieved representative examples of participants' motivation to join the programme. We computed summary statistics of the number and format of workshops conducted; number of participants per workshop; and number of workshops attended per participant. We counted the number of Challenges,

corresponding Actions, Feedback and Syntheses, created and reviewed. We described the thematics and scope of the Challenges with a peer-reviewed description using content analysis (Cohen et al., 2017b) (protocol in Appendix S6). We explored the extent to which the growing database of Challenges could grasp the concerns of newcomers. To do so, we calculated the number of new participants that were needed for a new Challenge to be suggested. Finally, we described the nature of the collaboration happening as groups of individuals contributed to the same Challenge. We evaluated to which extent these collaborations implied individuals with different educational roles and from different geographical departments or countries.

Research reproducibility

The essential tools to implement the TaR methodology are the templates to produce the different objects, field notes and peer-review prompts. They may be updated when improvements are identified. An English translation of the versions used in this study are available in Appendix S1, S2 and S3. A version history of the French tools is available on our website in print-ready format and as collaborative on-line documents (<https://profschercheurs.org/notre-demarche>) under the licence CC:BY-NC-SA.

This study was preregistered with the Open Science Foundation on 15 April 2021 (<https://osf.io/h5cwy/>). All data analyses were done in R v3.6.3. Raw datasets and codes are shared upon request.

Results

Challenge example - How to help a disruptive student control his or her violent outbursts?

We start by providing a short narrative of the work conducted by a group of educators who joined the programme at its beginning and provided the largest amount of effort on a Challenge. The objective is to show the reader an illustrative example on how the TaR programme engaged educators to produce structured practice-based evidence.

Ms A, a primary school teacher from the Parisian suburbs, joined one of the first workshops of “*Les Mercredis du CRI*” in October 2020. She came following the recommendation of her district manager, who was in contact with the research team. Based on her personal concerns, she suggested a new Challenge entitled “How to help a disruptive student control his or her violent outbursts?” (in French: “*Comment aider un élève perturbateur à maîtriser ses accès de violence ?*”). A couple of weeks later, Mr B, a secondary school teacher from another French region who discovered the programme through social media joined a “*Les Mercredis du CRI*” workshop. He saw the Challenge and shared with the facilitators his interest to work on it. He was guided during that workshop to contribute to the written description of the Challenge, thus building upon the work previously done by Ms A.

Ms A invited two colleagues (Ms C and Ms D) to join workshops to work on that same Challenge. They benefited from the support of their district manager to count 18 hours of workshop attendance as part of their mandatory yearly PD. Mr B continued coming to workshops more than twice a month during his free time. These four participants constituted a core group of educators that regularly joined workshops throughout the year to work on that specific Challenge, even if the four of them were not simultaneously present in all workshops. Three additional occasional contributors from other French regions joined workshops to collaborate with the core group at different stages of the research. In total, 23 workshops included activities related to this Challenge.

After 6 workshops done over two months, the description of the Challenge was finalised, peer-reviewed and improved, and educators started suggesting Actions in December 2020. Three Actions were described and subsequently peer-reviewed: an observation-based Action entitled “Identifying the triggers of

disruptive behaviours”, and two others entitled “Establishing a contract with the disruptive student” and “Reinforcing the positive behaviour (opposite to the disruptive one)”. Between February and March 2021, five educators (the core group and an occasional contributor, Ms E) planned the implementation of one of these Actions and produced ‘field notes’ to guide their contextualised observations of variables such as the number of disruptive events caused by the student, the perceived intensity of that disruptive event, or the time without any disruptive behaviour during a session. Observations were planned at different paces according to each other's contexts (every day, once or twice a week in a specific time slot, or each time an event occurred). Starting mid-March 2021, the four educators from the core group provided Feedback which were peer-reviewed.

The Action entitled “Identifying the triggers of disruptive behaviours” received two Feedback from Ms A and Mr B. Both concluded that simply observing did not help improve their challenging situation. However, both reported that observing helped them better understand the underlying causes of disruptive behaviours, which may help them better design targeted interventions to decrease them. Both provided as supplementary material the observations collected to support their claims. The Action entitled “Establishing a contract with the disruptive student” received Feedback from Ms C and Ms D who respectively concluded that implementing that Action helped “a little” and “sufficiently” in addressing their challenging situation. They did not provide the data they had planned to collect to support their claims. Additionally, Ms E prepared to implement the Actions entitled “Establishing a contract with the disruptive student” and “Reinforcing the positive behaviour (opposite to the disruptive one)” but did not provide Feedback. A total of 10 peer-reviews were conducted at different stages of this work: 2 for the Challenge description, 4 for the Actions, and 4 for the Feedback. The 7 educators that co-authored some of the different objects and 11 additional educators contributed to peer-review.

This collective work was submitted and presented by two members of the core group during a research colloquium (Benomar et al., 2021). All written descriptions, narratives, supporting material and peer-review reports are made publicly available by coauthors in the Challenge specific page: <https://plateforme.profschercheurs.org/projects/l8BgzsdU>.

TaR communities

During its first year of implementation, the TaR programme was expanded to educators outside the direct reach of the research team through the training of facilitators. Respectively 17 and 18 individuals joined the first and second facilitators training. Following the training, 14 facilitators established 9 TaR communities. Most facilitators had as main responsibility supporting or training teachers (N=9), while others were teachers themselves (N=4) or other educators (N=1). TaR communities were created on the initiative of facilitators for a high variety of reasons: addressing the challenges shared in a school, those of teaching a specific discipline, those around a common theme of interest, or the challenges of a specific professional role (Table 1). Half of communities obtained institutional support to recognise workshop attendance as PD activities.

Including the facilitators, a total of 163 educators (69.9% female) joined the TaR programme throughout the year as TaR communities were created and recruitment efforts were undertaken (Figure 2). 58 (36%) and 39 (24%) participants were teachers at primary and secondary school, respectively; 31 (19%) had as main responsibility supporting teachers, 16 (10%) were teachers at university-level and/or researchers and 19 (12%) were other educators including project managers, or members of NGOs. Public (85%) and private (10%) educational institutions with deprived (15%), privileged (9%), or mixed (77%) socio-economic status were represented. Primary and secondary school teachers had a median of 16.5 years of teaching experience (range: [0, 39]). While the project physically started in Paris, participants from 28 (out of 101) French departments joined (Figure S1), as well as 5 participants from other french-speaking countries or international schools abroad France (Germany, Belgium, Cameroun, Spain, Switzerland). In France, the Occitanie region (*Académie de Montpellier*) was the most represented. In fact, in December 2020 regional authorities from the rectorate of the Académie de Montpellier assigned a district manager to the task of “developing the cooperation between educators” at the regional level, in line with recent national policies calling for the creation of communities of educators as means for PD (Ministère de l'Éducation nationale et de la Jeunesse, 2019). This district manager associated the TaR programme with his designated task, and consequently instigated the creation of 6 TaR communities during the year, all of which benefited from institutional support. Some examples of participants' motivations to join the programme were: “to exchange with other colleagues to enrich my practices”, “to reflect about my

practices”, “to experiment and learn to analyse my observations”, “getting closer to research”, “to develop my professional competencies”, “to experiment the methodology to create my own community”, and “to share with the community the research results I’ve discovered during my master studies”.

Participants were unevenly engaged with the TaR programme. A total of 127 (78%) individuals (including facilitators) joined at least one workshop. Although 77 participants subscribed to “*Les Mercredis du CRI*”, only 36 of them attended at least one workshop. Those who did not may have heard about the programme through colleagues or on the internet, subscribed but did not join a workshop. For the other communities, the number of community members (not including facilitators) ranged from 3 to 26, and most of them attended workshops (Table 1). With the exception of one incipient group not yet active, TaR communities offered a total of 118 workshops (range [1, 36]), totalling 223 workshop hours, mostly online (97%). The number of workshops conducted by communities other than “*Les Mercredis du CRI*” increased steadily over time (Figure S2). In addition to the facilitators, there was a median of 5 participants per workshop (range [1, 25]). For community members (excluding facilitators) subscribed before January 31st 2021 (N=73), 19% joined at least one workshop per month (Figure S3).

Collective research efforts and outputs

The study period started with 22 Challenges, 39 Actions to address them, 49 Feedback, and 0 Syntheses. The pre-existing objects had been produced during the initial phase of this project and had not been peer-reviewed (see Appendix S5). After one year of collective work, 38 new Challenges were suggested, 48 new Actions were suggested, 20 new Feedback objects were shared or under development, and 0 Synthesis were produced. Most participants (N=77) joined a single Challenge, 30 worked on two or three Challenges, and 7 worked on four or more.

Twenty three Challenges were peer-reviewed. Reviewed Challenges targeted primary school only (N=3), secondary school only (N=2), both primary and secondary school (N=12), and altogether primary, secondary and higher education (N=6). These Challenges addressed a wide range of topics to support students’ development within formal educational institutions (N=13) and outside formal educational institutions (N=4), and to support educational institutions themselves through PD and management (N=6) (Table 2). On average, a new Challenge was suggested after 3 new participants began joining workshops. We expected that by the end of the year new participants would find more often in the database an existing

Challenge grasping their concerns as compared to the beginning of the year. However, this was not the case (Figure S4). This suggests that the database of Challenges is not yet sufficiently large to encompass all concerns of educators in France.

By July 2021, only 9 Challenges had at least one peer-reviewed Action, and a unique Challenge (the one described in the narrative above) had at least one peer-reviewed Feedback. Challenge descriptions were sent to peer review after a median of 3 workshops (range [1, 8]), and Actions after 7 workshops (range [5, 9]). For the unique Challenge with peer-reviewed Feedback objects, 19 workshops were conducted before reaching that stage of advancement. In the few cases reported here, participants started reporting their observations as Feedback only after 5 months of regular work (Figure 3). This is reasonable as some cumulative work is needed to formulate Challenges and Actions, to implement new strategies, and to collect and analyse contextualised evidence.

Collaboration

Participants were able to work together on common concerns despite having different roles or working in different geographical areas. A median of 3 educators (range [1, 10]) joined each Challenge. In half (51%) of the Challenges, the coauthors were educators with different roles in education (e.g. primary *and* secondary school teachers, or primary school teachers *and* teacher trainers). In 42% of the Challenges, the coauthors were educators from different geographical departments. Half of the participants (54%) joined a Challenge that was initiated by someone else.

Discussion

We presented the Teachers as Researchers programme, a citizen science project to build a community of educators akin to a scientific community, publishing structured practice-based evidence. Guided during workshops by the research team and trained facilitators, volunteer educators described common Challenges from the background of their concerns, identified possible Actions to address them, shared Feedback reporting practice-based evidence on the observed effects of each Action, and peer-reviewed each others' work. This collective work was made public in a collaborative publication platform. In its first year of implementation, 127 educators across France (and abroad) including primary, secondary and university teachers, school staff and researchers joined at least one of the 118 workshops that were offered. A total of 60 Challenges ranging from the improvement of instructional strategies to school management were published in the platform. Our results suggest that the TaR programme supports the production of rich and structured practice-based evidence, is adaptable to a high variety of educational concerns and contexts, is engaging, and is scalable.

We argue the TaR programme has the potential to build a knowledge base for educators by engaging a high number of educators in the creation of a database of practice-based evidence that is of quality, transferable, accessible, and over which relevant cases are easy to identify. To ensure the quality of practice-based evidence, the TaR programme guides educators to apply research principles to inquire on their practices. It also guides them to do a complete reporting of their research through dedicated templates, and a peer-review system provides checks at all stages of the research cycle. Avoiding bias is a big concern in research. Whether a well reported research is free from biases is largely a methodological matter. For their research, educators may invite colleagues or researchers more removed from their context to observe action implementation and collect relevant data, use classroom recordings or do collective analysis of students' work (Schildkamp, 2019). Educators could also develop ad hoc experimental designs to examine causal relations between their Actions and the observed effects (Plavnick & Ferreri, 2013).

As with research practice generally, participants may need to accumulate first-person experience to develop a critical eye and get confident in using research methods. Nonetheless, research protocols must not become a burden for educators, lest they become demotivated. In the Challenge example we described in detail, two educators did not provide the data they planned to collect in their Feedback, maybe because

collecting and sharing it was burdensome. Not having that data as a support may decrease the confidence others have on their conclusions. As additional Feedback objects become available further work will be needed to examine the different research designs used by educators, and to assess how the different designs and levels of reporting may affect others' confidence on educators' conclusions. Ultimately, this may allow producing methodological recommendations to educators to improve the quality of their practice-based evidence.

To ensure the transferability of practice-based evidence, it is important to obtain contextualised Feedback from different educators implementing common Actions. Each piece of practice-based evidence (each Feedback) is constrained by the context in which the experiment took place, but at the same time is associated with an Action that could potentially be implemented in other contexts. If a Feedback is compelling for educators, the description of the Action will provide them with the possible contexts of application and the details of implementation. The peer-review system contributes to ensuring this transferability by explicitly questioning reviewers about the capacity for a given Action to be implemented in different contexts.

The shortcoming of accessibility is addressed mainly through the peer-review system and the publication platform. First, content written and peer-reviewed by educators may have higher chances to be understood by other educators as opposed to content written by actors removed from the practice (e.g. scholars). Second, through the collaborative publication platform, educators' research becomes accessible to others in a centralised place. The TaR methodology could be implemented by a local group of educators in a low-tech mode, with paper copies of the templates, and using a message board to share each others' writings. However, we argue its true potential is revealed when locally produced research is accessible to other local groups for them to collaborate and learn from each other. More than half of participants contributed to a Challenge that was initiated by others, attesting to the usefulness for educators to have access to the (ongoing) research conducted by others.

To help educators identify relevant case studies to inform their practice, we suggest an indexing of practice-based evidence (Feedback) based on educational concerns (Challenges) and possible strategies to deal with them (Actions). By design the Feedback from all educators who are experimenting Actions targeting the same Challenge will be explicitly linked in the database. This feature allows the evidence produced to be more easily compared, aggregated and synthesised than if we merely collected a large list

of independent case studies. Starting the indexing procedure from common Challenges is in line with Kennedy's (2005, p10) proposal to parse teaching practice "focusing on challenges, rather than on solutions, [to] help [teachers] learn to think strategically about how their actions address a larger purpose". Other educational stakeholders, while potentially collaborating with teachers to address their challenges, are confronted with other kinds of concerns for which they need professional knowledge (e.g. school management, link with the families). Without having an exhaustive taxonomy of educators' challenges, we used a bottom-up approach for indexing: educators suggest new Challenges and Actions if they do not appear in the database. Thanks to peer-review, Challenges are organically collapsed, reformulated, narrowed down or expanded to make sure they are general enough for others to feel concerned about them, but specific enough to call for concrete Actions. An anecdotal example is the case of the challenges of adapting and differentiating practices for students with special needs. Two suggested Challenges entitled "How to adapt teaching practices to help all students with special needs?" and "How to differentiate practice without increasing the differences between students" were merged into a unique Challenge following peer-review. Then, reviewers considered the merged Challenge too broad, and coauthors created five Challenges to separately treat the adaptation of teaching practices for students with difficulties in reading, writing, speaking, reasoning and engaging in learning tasks. Indexing the practice-based evidence on a given Challenge according to common Actions creates professional knowledge about concrete, conscious and potentially replicable decisions educators could make. It therefore excludes the professional knowledge required to react in pressing or unexpected daily situations (Clark, 1984), or the one required to run less replicable strategies such as complex interventions needing the coordination of a high number of stakeholders for a sustained period of time (e.g. implementing a reform at a district level).

Finally, we suggest that several features of the TaR programme contribute to engaging educators in the creation of practice-based evidence. We discuss them through the lenses of the three basic psychological needs from the self-determination theory: autonomy, competence and relatedness (Ryan & Deci, 2000). First, educators may be more motivated as they can be autonomous in defining by themselves their own research question and protocol, starting from their own concerns and practices. Some communities such as "*Les Mercredis du CRI*" may also allow members to come to workshops according to their own personal constraints, contributing to their autonomy to define their own schedule. Second, motivation may be enhanced as educators' are seen within the TaR programme as having the

competencies required to be active inquirers of their practices. Acknowledging workshop participation as a PD activity contributes in this direction. The platform may also increase educators' professional reputation as publishing their work may attract attention from other educators. Third, the TaR programme may motivate educators as it contributes to their relatedness within professional communities. During workshops, educators can share with their peers their concerns in an atmosphere of mutual trust and respect, which can support them to process new understandings and develop new perspectives (Timperley et al., 2007).

One limitation of this study is that not all participants were evenly engaged with the TaR programme, as only one fifth of participants came to more than one workshop a month. Additional work is needed to better understand participants' motivation to join the programme, and the reasons leading to an increase or decrease of engagement on time. Nonetheless, the division of the research cycle into independent activities through the TaR methodology allows the collective research effort to advance even if a high proportion of educators join workshops only occasionally.

The term *citizen science* in the educational scientific literature has been coined out mostly in relation with the capacity of citizen science projects to promote learning (Phillips et al., 2018). In this work, we suggest using the term citizen science as a methodological framework to conduct research about teaching and learning. It has been rarely used in this context, probably because of the longstanding history of participatory approaches in educational sciences as compared to natural sciences, in which the concept of citizen science has been mostly used (Tauginienė et al., 2020). We think the TaR programme should be considered a citizen science project because, in addition to the inclusion of educators in all the stages of the scientific process, it is designed to lead to new knowledge and to improve our understanding on how to address the challenges of education (Robinson et al., 2018). To address educational science questions, to our knowledge one unique research paper has used the term citizen science so far (Letang et al., 2021). In that work, researchers defined the research question, the outcome variables and the experimental design (randomised controlled trial). Teachers and researchers collaboratively defined the experimental and control intervention, conducted the randomization and collected the data. Finally, researchers analysed and published the results. This and other forms of research-practice partnership could be hosted within the TaR programme (Coburn et al., 2013). Researchers specialists in a particular topic may join workshops or conduct peer-reviews to help educators in their research. This was the case for one particular Challenge

concerning the promotion of students' collaboration, where facilitators invited a French researcher specialist in that topic to peer-review the work of the community.

In conclusion, we developed a community of educators akin a research community producing and publishing practice-based evidence on how they address a high variety of educational challenges.

Author contributions

IA, MP and NJ conceived and designed the study. IA, NJ and CG ran the workshops and the facilitators' training. IA acquired and analysed the data. IA, NJ, MP and PD interpreted the data. IA and MP drafted the initial manuscript. IA, NJ, MP and PD contributed to subsequent revisions. All authors read and approved the final manuscript.

Declaration of interests

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Ethical committee approval

This work was not submitted to an ethics committee during the first year of implementation reported in this manuscript, as the entire protocol of the TaR programme was not ready before we started recruiting participants in Sept 2020. At sign-up participants voluntarily chose to be included or not in this cohort study. Subsequent and similar studies reporting the implementation of the TaR programme from September 2021 onwards received approval from the INSERM ethical committee (IRB00003888, IORG0003254, FWA00005831).

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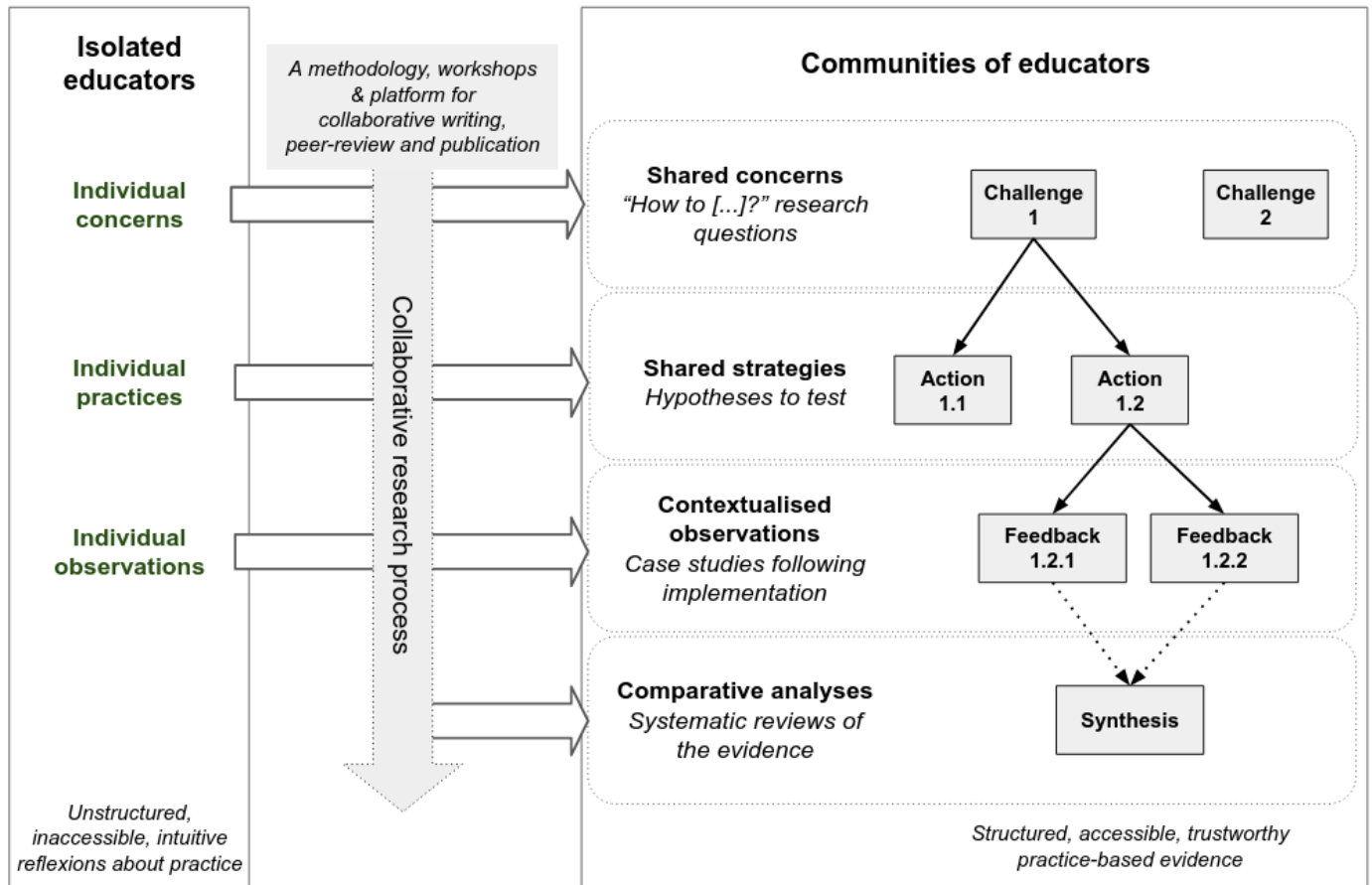
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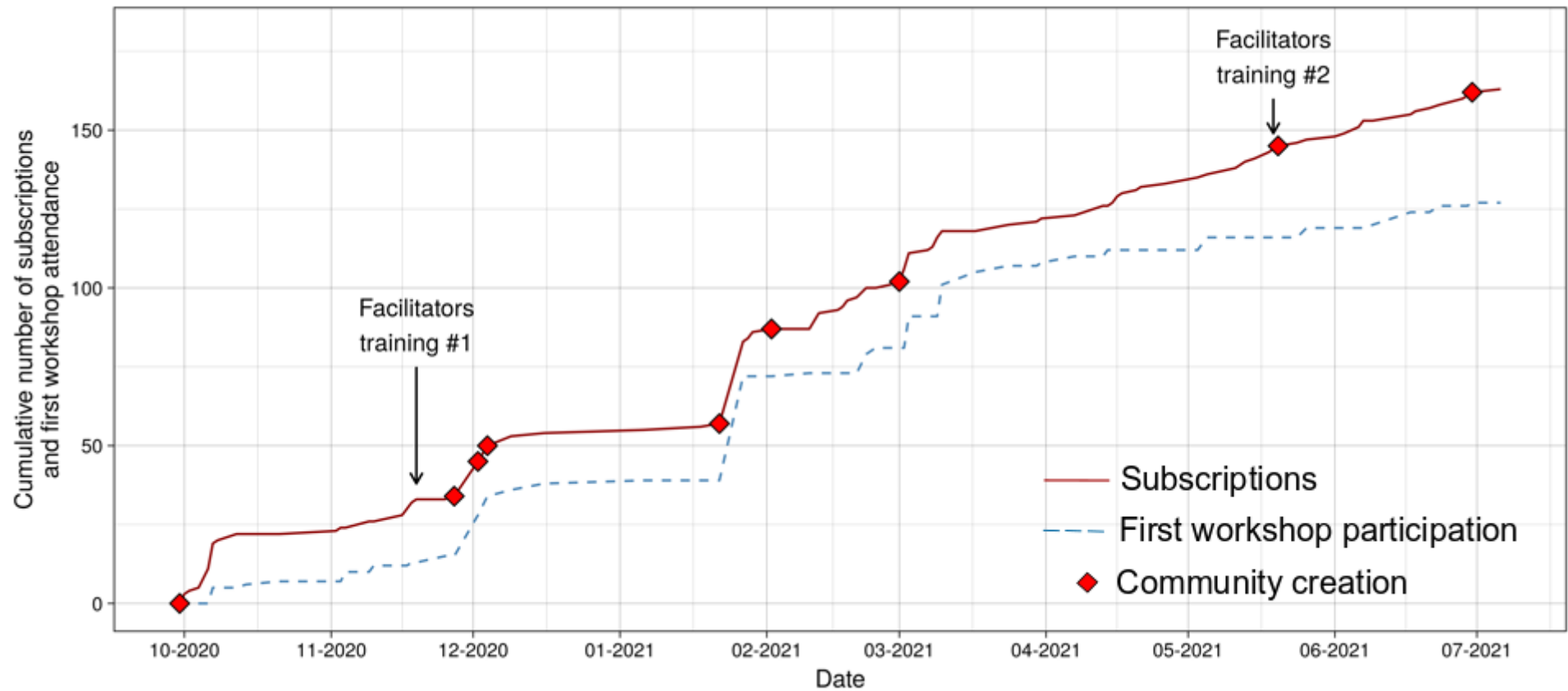
Figures and Tables

Figure 1 - The four activities of the “Teachers as Researchers” methodology and the logical relationship among the resulting objects



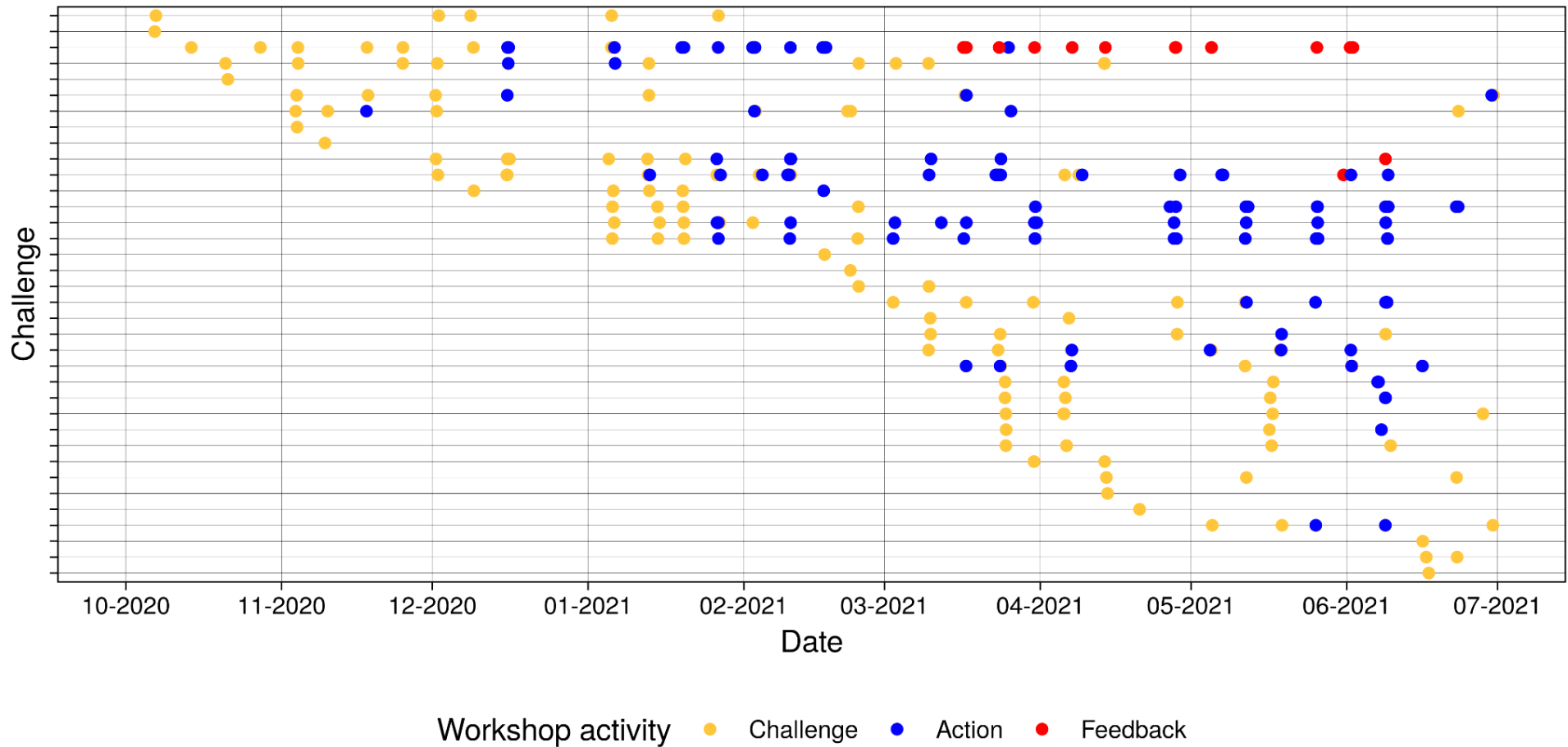
The “Teachers as Researchers” methodology is structured around four activities in which educators engage: identifying Challenges; identifying Actions; sharing Feedback; and producing the Syntheses. Each activity results in the production of written objects of the corresponding type: Challenge objects, Action objects, Feedback objects, and Synthesis objects. These objects are naturally linked to each other. In particular, each Action is defined in relation to a specific Challenge and each Feedback reports the implementation of a specific Action (and thus a specific Challenge). Syntheses are aggregated analyses of several Feedback shared for a single Action, for a set of Actions related to a single Challenge, or for another combination of interest.

Figure 2 - Cumulative number of subscriptions to the “Teachers as Researchers” program



Cumulative number of subscriptions to “Teachers as Researchers” communities (red line), cumulative number of educators joining at least one workshop (blue dashed line), the dates of community creation (red rhombus) and the dates of facilitators training (arrows).

Figure 3 - Workshop activities per Challenge



Activity per Challenge on time: each line represents a Challenge, each dot represents a workshop addressing that Challenge, and the colour represents the activity of the “Teachers as Researchers” methodology conducted. The participants working on the same Challenge are not necessarily the same for all workshops, and one participant may have joined workshops addressing different Challenges.

Table 1 - Description of the “Teachers as Researchers” communities created

Community name	Date creation	N facilitators	N participants subscribed (have attended workshops)	N workshops	Median [range] participants per workshop (1)	Members: shared thematic or context	Institutional support for facilitators to run the community	Institutional support for participants attendance to workshop
Les Mercredis du CRI	30 Sep 2020	3	77 (36)	36	4.5 [1-9]	All thematics, all contexts	Facilitators were part of the research team	For 3 and 1 participants, 18h and 8h of workshops were officially counted as part of their continuous professional development, respectively.
DevC_SEGPA	02 Dec 2020	4	13 (10)	19	3 [2-10]	Educators in SEGPA (2) in the same region	Preparing and running all workshops was officially considered as a training activity.	For all participants, all workshops were officially counted as part of their continuous professional development.
Différencier sans exclure	04 Dec 2020	1	7 (7)	7	3 [2-5]	Educators interested in the thematic of students with special needs	Preparing and running 8h of workshop was officially considered as a training activity.	For five participants, 8h of workshops were officially counted as part of their continuous professional development.
DevC_Communauté	09 Dec 2020	3	8 (7)	17	5 [2-7]	Educators from the same region, all thematics	Preparing and running all workshops was officially considered as a training activity.	For all participants, all workshops were officially counted as part of their continuous professional development.
Circonscription Agly - Directeurs	27 Jan 2021	7	26 (25)	21	5 [2-25]	Primary school directors from the same district	Preparing and running all workshops was officially considered as a training activity.	For all participants, all workshops were officially counted as part of their continuous professional development.
DevC_TIERS-LAB	11 Feb 2021	3	10 (10)	7	5 [2-6]	Educators in charge of FabLabs at schools in the same region	Preparing and running all workshops was officially considered as a training activity.	For all participants, all workshops were officially counted as part of their continuous professional development.
Ecole St-	02 Mar	1	6 (6)	1	6	Educators from the	The facilitator was part of the	None

Raphaël	2021					same primary school	research team	
DevC_ROSA-PARKS	02 Mar 2021	3	18 (13)	8	6 [2-8]	Educators from the same secondary school	Preparing and running all workshops was officially considered as a training activity.	For all participants, all workshops were officially counted as part of their continuous professional development.
DevC_MECA	21 May 2021	4	4 (4)	1	5	Educators from the discipline "Vehicle and equipment maintenance" in vocational high schools in the same region	Preparing and running all workshops was officially considered as a training activity.	For all participants, all workshops were officially counted as part of their continuous professional development.
SOLALECOL E	01 Jul 2021	1	0	0	NA	Educators from all regions interested in soil education	None	None
InterCommunity Workshops	-			1	11			

(1) During workshops, some facilitators may punctually take the role of a participant if there are too few participants present as compared to the number of facilitators (e.g. less than 2-3 participants per facilitator), and if the tasks of the workshop are relevant for the facilitator as an educator. In this column, facilitators playing the role of a participant are counted.

(2) In France, SEGPA (Sections d'Enseignement Général et Professionnel Adapté) are classes designed for special needs students, provided by mainstream lower secondary institutions. Most students face major social issues or learning issues (<https://www.insee.fr/en/metadonnees/definition/c1866>)

Table 2 - Categories of the peer-reviewed Challenges

Themes - Sub-themes - Categories			Number of Challenges
Supporting student development			17
Within formal educational institutions			13
		Adaptation/differentiation for students with special needs	4
		Student assessment	2
		Students' critical thinking	1
		Students' emotions	4
		Distance education	2
Outside formal educational institutions			4
		Link between educational institution and families	2
		Link between formal education and professional life	2
Supporting educational institutions			6
		Professional development of educators	3
		Management of educational institutions	3