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# Investigating leading variables and concepts in the study of teaching and learning spaces

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*Résumé : Ce chapitre recense les variables et les facteurs les plus déterminants pour étudier l'architecture scolaire et les formes des espaces d'enseignement apprentissage à travers une revue de littérature en utilisant les méthodes de la textométrie. Notre corpus est composé d'articles du Journal of Learning Spaces et des publications de l'OCDE de 1997 à 2022. Les résultats montrent une instabilité des variables et facteurs étudié tout au long des années.*

*Summary: This study investigates the most determinant variables and factors to study the design of learning and teaching spaces through a literature review using the methods of textometry. The corpus of the study comprises articles from the journal of learning spaces and publications by OCDE from 1997 to 2022. Results show that the variables and factors mobilized by researchers vary significantly from one year to another among authors and organizations.*

Keywords: school architecture, learning spaces design, learners and teachers' well-being

## 1. INTRODUCTION

The study of spatial aspect of schools has been left to architects for a long period (Châtelet, 1999). On the other hand, the making of the teaching spaces has always been tightly linked to the political decisions and the economic context (Derouet-Besson, 1998). However, the pedagogical aspect could not be totally ignored. Thus, the practices labeled as “modes” were the roots of the first attempts to think of the design of the learning and teaching spaces in schools as a pedagogical decision (Lainé, 1996). The mutual mode, the simultaneous mode, as the semi-simultaneous mode had each their own design and organization in line with their methods and needs. Different thinkers and educators, such as La Salle (1720) and (Jomard, 1816) were distinguished as the frontrunners and pioneers of the traditional designs of learning and teaching spaces. The enforcement of the Guizot Act (*Loi sur l'instruction primaire - Loi Guizot, 1833*), was a pivotal moment in the process. In the early 20th century, there was a shift of concern toward a more hygienic approach to learning spaces which first appeared in Germany before making its way to France (Schneider, 2004). The first international congress of outdoor or open-air schools was held in Paris. (*Premier congrès international des écoles de plein air - Archives de Paris, s. d.*) The frontliners of this movement were mainly health specialist and architects namely Bechmann, & Marchoux (2017) who published together a guide with hygienic and building instructions for open-air schools. Later, the concern about the capacity of schools to receive all students who are old enough to get education became

the driving force. That situation was triggered by two major acts in the history of education in France : the Ferry act (1882) making school free and compulsory and the Haby act published in 1975 (*Loi n°75-620 du 11 juillet 1975 relative à l'éducation*, 1975.) The pedagogical aspect started to be properly taken into account after the publication of the Deygout bulletin (1978) in which the author attempts to draw a consistent relation between space design and pedagogical benefits.

From the late 20th century, educationalists such as Pavlov & Le Ny (1963), Bruner (1966), Freinet (1969), Piaget, (1977), Lev Vygotsky (1994) and their colleagues developed learning theories which give different roles to the environment in which the learning is taking place. Each of these theories offers a new understanding of learning spaces. Thus, a close look on the evolution of school learning spaces offers a view of a timeline on which pedagogical theories, legal frames, political motivations and socio-technical consideration interact simultaneously or successive to build the best form of learning and teaching spaces (Barthelemy & Jeannin, 2019).

In this paper, we will set the theoretical framework for the study of learning spaces. Then, we will propose a review of the most significant works in the field. Following that, we will study how the learning spaces are approached by educationalists and political institutions through the analytic comparison of a corpus composed of publications from *the journal of learning space* and a corpus of articles from OCDE publications. The presentation of the results will provide us with the necessary material to sustain our discussion and put forward some recommendations.

## 2. THEORITICAL FRAME

In this study we are going to analyze the notion of learning spaces as addressed by the two institutions mentioned in the introduction (*The journal of learning spaces et l'OCDE*). The choice of our approach can be justified by the fact the relation between people, institutions and knowledge can be scanned through the discourses of the mentioned part-takers. (Chevallard, 1988). In fact, the evolution of the relation between knowledge and institutions can be explained by the referencing that the latter operate on the knowledge it produces and the general knowledge.

For this reason, among others, we will use the principles of textmetrics to verify and challenge our first impression about the situation of researchers in the field of learning spaces studies. As part of this project, we are going to provide some recommendations based on the analysis of the corpus using the theoretical framework explained in this section.

### 2.1 A brief story of the practice

The practice which is known today under the name textometry was born in France in 1970 from Guiraud and Muller who were the first to publish research about the statistical analysis of texts focused on the quality of the vocabulary used in the corpus. Walking on the path of these pioneers, Benzécri introduced the factorial analysis and the classification inherited from the methods used in domain of data analysis. Thanks to this technique, it was, then, and is still possible to generate graphics and various types of representations of the words of a corpus according to their affinities or their disconnection (Pincemin, 2008). With the development of the techniques and the technologies involved in the activity, programs were able to perform

more tasks and take in charge further parameters. They became capable of counting the words based on their nature, their repartition within the collection of texts in a given corpus. Furthermore, they became proficient in describing the linguistic and textual pattern such as the morphosyntax, the textual syntax etc.) (Pincemin, 2020). The term textometry started to be more used in the communities or researches along with the term logometry to refer to these practices consisting of conduction statical analyses on textual corpuses. In addition, the practice of textometry is sustained by a certain number of concepts.

### *2.2 Concept and application*

Pincemin (2020) considers the concept of textometry as “a methodology which covers a large scope of analyses in coherence with the textual corpuses in the domain of the humanities and social sciences.” But she warns the researchers about the paramount importance of human judgment in the matter. The machine does not provide answers. The results of the analysis are not definitive scientific conclusions. They only provide information for the author to decode in the light of the context. On this remark, the point of Rastier (2011) is of great relevance as he states that the automated operations in the software must be considered as “moment of suspense for the interpretation”. That step of interpretation is vital for the sake of the rigor required by science but also for the cultural and semantic dimension of the process. We find this assertion very meaningful and very eye-opening. We can think of a detective series in which the latter gathers clues and evidence. There is always the scene when the other characters and the suspects gather and listen to the reasoning, the account and the interpretation of the detective based on the collected evidence to give his verdict and reveal who committed the crime. This perfectly illustrates the point of Rastier about textometry. In the framework of textometry, the repartition, the frequencies, the similarities and other statistical data are clues for the investigator. Actually, looking into the text through the prospect of the elements mentioned just before is to make the hypothesis that words and occurrences have identities of their own. Besides, the analysis of Reinert can give precious information about the evolution of a word, a theme or a concept. It is also possible to analyze the sub-corpus and compare its differences and irregularities vis-a-vis the primary corpus (Rastier, 2011). In addition, the concordances analysis can help understand the regularities of some constructions in the corpus, the analysis of the specificities allows us to evaluate the quantitative variations of use between the different subparts of a corpus and the factorial analysis of the correspondences makes it possible to obtain a global and synthetic visualization of the main dimensions of the contrasts that structure the corpus (Lebart & Salem, 1994). Another important asset of textometry is the possibility of limitation which allows to track the occurrence of the forms from the root of the word and this gives a wider view on the relations in the corpus (Geffroy & Lafon, 1982). Likewise, Textometry gives a vast scope of analysis and many levels of interpretation by taking into account synonyms and polysemy. This way the researcher can include contextual and linguistic aspects such as the implicit part of the corpus (Carbou, 2017).

### *2.3 Parameters and precautions*

In the first place, the methods of textometry are not primarily designed for small corpuses. They are more relevant for analyzing corpus with a large number of texts. (Pincemin, 2020). it is important, nevertheless, for the researcher to know the corpus he is working with. He should also choose carefully the texts which compose the corpus. Quantity must not be the only criterion. The researcher has to give critical attention to the quality of the texts. Plus, the

corpus must not be too big (Geffroy & Lafon, 1982). The analysis of the occurrences of a word is a significant material for researchers but it is necessary to bear in mind that there must be some caution for a word can have different meanings depending on the writer and the context. For example, the French word “ombre” has different meanings depending whether it is from Baudelaire or Hugo (two French poets). It may be also be useful to ignore the ambiguous units in order to have a more readable/ doable corpus (Guiraud, 1960).

The analysis of the corpus is a continuous process. The researcher needs to adjust all along his studies. At the end, the result will always be partial with flaws. Even if the pursuit of perfection must be the motivation. The results of the analyses from the software are never perfect for the corpus itself will bear some flaws. However, these imperfections do not invalidate the conclusions of the research (Pincemin, 2012, 2020). Besides, a particular attention must be given to the interpretation of the results in order not to fall into obvious results. A good way for that is to look for disruptions, irregularities and unexpected events (Geffroy & Lafon, 1982). Though it is possible to come up with findings already demonstrated in other studies, we can still go further by extending the scope of analysis which will provide more factual evidence.

### 3. PROBLEMATIC OF THIS STUDY

The researchers working on the question of learning spaces adopt very diverse approaches resulting in different forms of publications. The methods in use range from historical, analytical, projective, policy-directed, health-oriented, learning-centered, and so on and so on. It goes without saying that a researcher can have many different approaches from one study to another. Still, it is relevant to question the way this approach developed. In other words, we could ask the following questions. Is there an established approach in the study of learning spaces? Can we identify a largely shared focal point in this field of study? What variables and factors are investigated by the authors of the articles in *the journal of learning spaces* and OECD? The first has an academic status and the second holds a political position. Nonetheless, both are international and multidisciplinary. For these reasons, we think they will provide us with reliable, sound and significant material to carry out a useful and timely study.

### 4. METHODOLOGY

In this section we will explain the methodology we used to collect and analyses the data in our corpuses.

#### 4.1 Data collecting method

In this study, we used two methods to collect data. The first one was applied to the corpus comprising the articles from the *Journal of learning spaces*. All the volumes are available on the website of the journal. First, we exported the references of all the articles of the journal in Zotero from the first volume to the last (2012-2021). Then, we exported the references from Zotero to a CSV format. For both corpuses, we needed to complete some keywords (when not provided in the metadata of the articles) from our own reading, often using the words in the title or in the abstracts when available. At the end, we collected 524 tags (186 OECD, 338 JLS), 275 authors (68 (identified) for OECD and 207 for JLS) and 183 articles (80 for OECD and 104 for JLS). The choice of the articles for OECD was based on some criteria. Indeed, we used a

first set of references collected by Jeannin. Then we selected those which were documented enough (author name, published from 2012 onward, using words related to school space). It is interesting to note that previous studies in the field of learning spaces have mostly adapted a literature review approach but the originality of this work we conducted is to use the emerging methods of textometry. For instance, Barret and al. thought that gathering a set of studies in the area of school architecture and learning could help reach a better understanding of the implications of the subject. In their report divided into 6 chapters without taking into account the one dedicated to the conclusion and discussion, the multidisciplinary and transnational research team endeavors to give a wide range of evidence which sustain that school infrastructure has an impact on learning. Their work was a sort of review of relevant studies by other researchers, a kind of a bibliographical reference in the topic. The primary material of the study was a bunch of “*129 publications devoted to the built environment of schools (including academic articles, research reports, books, and monographs)*”. The researcher intended to produce a “*thorough*” study. To do so, they selected the publications containing the most reliable and sound empirical evidence. The diversity in the type of publication in their primary corpus is good evidence of the variety of approaches and works on the topic. The transnational aspect of the corpus and the members of the research team can be explained by the fact that this review was supported by the World Bank Group. For the same reason, it is not surprising to find an important analysis of the economical implementation of the adaptation of learning architectures. Besides, alongside the question of students' needs and performances, the optimization of the investments holds a prominent position in the review. On that particular aspect they sustain that “*The evidence presented in this report shows that a wider range of salient factors can be addressed for the same amount of expenditure.*” (Barrett et al., 2018, p. 16). This remark is not a reproach but it shows how the approaches can be determined or at least influenced by the context in which the study is conducted and the stakeholders. In addition, the guiding questions Barrett and his colleagues addressed show, if need be, how varied the areas of study and focal points can be. As a matter of fact, the team phrased the five following guiding questions:

- First, do all children actually have access to a place at school?
  - Second, do the school buildings provide a safe and healthy environment?
  - Third, are the learning spaces optimally designed for learning?
  - Fourth, does the school's design facilitate pedagogy and community engagement?
  - Fifth, how can the school infrastructure be developed in a sustainable way?
- (Barrett et al., 2018, p. 20)

These guiding questions are respectively linked to the questions of

- The accessibility of the school
- Safety and health
- Optimal spaces for learning
- Synergy with the pedagogy and community
- The effective implementation of the school project.

The conclusions of the reviewing team put forward a clear relationship between the physical setting and the natural environment on the five points mentioned above. All the more, the nature of the work (review) could lead a non-specialist reader to think that it is a definitive and final statement, it might be the reason why the authors felt the need to point out that their work stands for a starting point meant to ignite further studies as they write “*However,*

*further studies are needed to explore what kind of spaces are best for learning in different disposition and size pedagogy and space at large scale*”(Barrett et al., 2018, p. 17) such studies need to examine indoor environmental quality taking into account air quality and dampness. The review also spots the need for managerial actions such as organizing training session for teachers on the methods and practices to optimize learning spaces in order to take full advantage of the space and improve students' health and learning which would be a key asset for a successful educational system. This vision is in line with the findings of Jeannin and Barthelemy as well as the those of Barrett and al. who identified the need for multi-stakeholder studies and actions to meet the challenge of performing a successful transition of the learning spaces and school architecture.

#### 4.2 Method of analysis

Following the collecting of the data, we exported and aggregated the CSV file from Zotero containing the bibliographic meta-data using a google-sheet file. The primary file comes with a lot of meta-data that we did not need for the current study. For this reason, it was necessary to organize the document to make it to be usable. After the aggregation we ended up with the following grid for our first analysis on the abstract.

Arcles	Date	Volume	*them_ID_ART	Resume
****Article1	*date_2021	*Volume_10	*them_2021_10_2_1	The physical space of campus may

Figure 1 : Preparation of the google-sheet for iramuteq analysis)

The content of the copy was pasted on an open-office document with the “paste special” function. The double tabulation at the end of the grid in yellow was replaced with a line break using the search and replace function. The tab between the two variables (\*date and \*volume) was replaced by a blank space. Thanks to these operations our file was ready for the textual analysis. The column « \*them\_ID\_ART » is the identification key of the article and is comprises the year of publication, the volume, the number of the issue and the order in the database. In short, it allows us to easily identify the article in the database. This step was a requirement before the analysis could be performed in Iramuteq.

To start with, we conducted textual analyses on two levels. In the first step, only the abstracts were used. We set the parameters by labeling the words and selected only nouns and verbs as active forms. We made that choice after we having tried many different settings which included adjectives, adverbs and other word classes. But those settings didn't provide sound results. This step allowed us to have a first sight of the concepts which were prominent in the *Journal of learning spaces*. Then, we used the statistical analysis to describe the corpus (number of elements, repartition ...), the specificities. An AFC analysis was conducted to investigate the classes of words, the evolution of the concepts along the years and their importance in the corpus. We also used the Reinart analysis to visualize the way the concepts are clustered and regrouped in classes. Finally, we performed an analysis of similitude to investigate the interaction between the concepts and the classes in the corpus. In the second step, we performed the same analyses on ten articles using their whole contents. Then, we extended the analysis to all the articles. In all these previous analyses we used the date of publication and the volume as variables. In the next step we included the authors as an independent variable. At this level, we focused our analysis with articles from the most regular

authors in terms of publication along the years. These authors were identified by generating a network visualization in Gephi which shows the links between authors and years.

In the second level of analysis, we used the whole contents of all the articles in the *journal of learning spaces*. The results of the analysis of the abstracts alone were compared to the results of the analysis of the whole content of articles to verify if we would end up with the similar results. Having a similar result would mean that abstracts are sufficient to perform a reliable textual analysis. After this work, we set ourself to understanding the relations between the contents of the publications and authors through keywords attached to the articles. The first step was to apply a textual metric analysis with Iramuteq. The analysis provided information about the number of times keywords are used and how central they are in the corpus. Although, it is important to mention that such an analysis doesn't provide information about the relation between keywords, years of publication, article and authors. Still, it can give an accurate overall view of the most and least critical concepts in the publications. We also visualized the links between the authors, the articles and the keywords using Gephi. For this analysis, we also needed to applied a specific organization of the data. Each author and keyword were individually associated with an article. That analysis and visualization provided information about authors involved in different articles, keywords used by different authors and articles. The visualization of that network and relations was made possible by the edges table containing the source, the target and the type of relation. On the other hand, we needed to create a nodes table which contains the labels and the Classes (keywords, articles, authors). This table also contains the metadata which are details people can view when the visualization is published online or using a local server.

The visualization in Gephi was produced with undirected nodes and the modularity and degree statistics were activated. The links were visualized by modularity class and the nodes by degree. The same procedure was used to analyze the relation between references in the articles, the articles and the authors. The model of the identification provides another level of studies because it contains the information about the year which will also be included in the interpretation of the results. The Gephi gexf.js file was used to put the results online using a MAMP server. This allows us to navigate through the visualization. Thanks to the meta-data in the Edges file, we can access valuable information on each article (author, summary, keywords, cover ...).

To go further in the analysis, we selected 10 of the articles with the highest number of links and we applied the same visualization parameters. But for this time, we replaced the keywords with the references of the articles to verify if there were largely shared references in the corpus. The same operation was extended to all the articles of the journal. This analysis was completed with a textual and a statistical analysis of the tags in Iramuteq. Thus, we conducted a frequency analyses, a multiple frequency analysis, and a prototypical analysis of the tags. Then, the results were interpreted in relation with findings from the outputs from generated using Gephi.

It is necessary to point out that, in the OECD corpus, the authors were replaced by the countries. This choice derives from the observation that some articles do not have nominative authors. Moreover, as the OECD has an international scope, we thought that considering the countries was more relevant. Another difference is that we had publications in two different



languages (English and French). To address this specificity, we performed all the analyses separately according to the language except for the AFC analysis which we conducted considering the publications in English only at the first place. We, later, added the French publication and conducted the AFC again. This strategy was chosen to have an internal comparison between the French and English literature in the organization. As for the visualization of the relations with Gephi, we used the same variables (keywords, articles, authors). When it comes to the final part of our research methodology, we interpreted each result within the context of production of the corpus studied. This first step allowed us to have the necessary material and understanding of both sources to carry out a comparison between the two institutions.

## 5. RESULTS

In this section, we will successively present the results from the JLS corpus and the one from OEDC publications.

### *5.1 Journal of Learning Spaces*

The visualization of the relations between the authors, the articles and the tags, displayed a very disparate distribution of the vocabulary and the variables used by the researchers. There are many keywords that are associated with one article only. The clustering has formed 63 communities out of 338 tags, 207 authors and 103 articles. We could identify no significant community within the authors, the tags or the articles. That finding suggests that the researchers work on different variables and concepts.

This observation must be nuanced knowing that some tags can be very close in meaning. For instance, the tags “active learning classrooms” (used in 2 articles), “active learning space” (used in 4 articles) and “active learning” (used in 4 articles) could refer to the same concept. The same caution is necessary with the tags written in singular in some articles and in plural in others. We also have key words used with adjectives such as “informal learning space”. So, this analysis takes into account the exact tags. Despite these necessary precautions, the number of relations remains very low given the number of variables. For example, the tag “active learning classrooms” which is one of the most shared between articles is present in 5 articles only which is very few. In the same way, the tag “active learning” is shared by only 4 articles and is one of the most transversal in the corpus. The sum of the number of times these two tags are used in different articles is 9 times which is still low. These two tags were exclusively used in 2020 and 2021 which means that they have gained ground during this period. In the same way, the tag “learning environment” is associated with 3 articles in 2016 whereas “learning space” is present in all the volumes of the journal. The tags “collaborative learning” (Attebury et al., 2020; Williams & Sato, 2021; Worsham et al., 2021) and “learning communities” (Altimare & Sheridan, 2016; Julian & Parrott, 2017; Rook et al., 2020) are also among the most active in the journal.

As far as the authors are concerned, very few of them are related to more than one article or year. Among them we can name Parsons who contributed in 3 articles (Parsons, 2016, 2017, 2018), Milo-Shussman, Mc Donald and Rook who contributed in 2 each (Milo-Shussman, 2017); (Milo-Shussman & Niva, 2019); (Rook et al., 2015); (Rook et al., 2020). The first contributed in 2017 and 2019 with a gap of two years between his publication. Other authors

such as Walker, Beapler, Crumpton and Parker contributed in two articles in a row of two years but disappeared afterward.(Walker & Baepler, 2017); Walker & Baepler, 2018; (Crumpton, 2016); (Crumpton, 2017); (McDavid et al., 2018). This first result of the visualization shows a low degree of relations between articles, authors, years of publication and tags. To have a more precise knowledge of the situation, we performed a textual and a statistical analysis with the tags in Iramuteq. This second analysis was also a way of double-checking the findings from the visualization in Gephi.

All the analyses performed with the tags of the articles in iramuteq support the result of the analyses performed in Gephi. These findings are very eye-opening. However, the outputs of the prototypical analysis are even more important in the context of this study. For this reason, the following lines are going to be dedicated to presenting them. In the first place, we found that the prototypical analysis confirms a great deal of what we found in the previous study with Gephi. The tag “learning space” is at the core of the articles and is often the first on the list of keywords used in the articles. The other tags at the center of the articles are “Classroom design”, “learning communities”, “learning environment”, “active learning space”, “active learning”. The secondary tags are “Student engagement”, “higher education” and “collaborative learning”. These new findings (from Gephi and Iramuteq) are very edifying on the concepts that are mostly dealt with by the authors. Nonetheless, they are based on the metadata only. For this reason, we extended the corpus by using the abstracts of the articles.

Regarding the abstracts, we had 10569 occurrences, 2133 forms and 1143 hapax (about 11% of the occurrences and 53% of the forms) with an average of 103 occurrences in each text. The specificity analysis and the AFC analysis offers a very disparate spectrum about the focal points of studies in the field of learning spaces among the authors of the Journal. To speak more bluntly, the focuses and the concepts change a lot from one year to another. The evolution of the presence of the notion of design in the abstract is a striking illustration of the situation. After a modest beginning with a value of 0.8 in 2012, it fell at 0.25 the following year before reaching 0.36 in 2014. In 2015 and 2016 the value declined gradually to negative values (-0.24 and -0.47). It suddenly skyrocketed in 2017 reaching a climax of 3.56. From that point, the value went through a free fall (-0,31 in 2018, -0,81 in 2019, -1,28 in 2020, -1,35 in 2021). In the same way the word building is largely used in the abstracts in 2014 with a value of 3,22 while it is very low in all the other years ranging between zero and negative values. Thus, this analysis confirmed the findings from the previous steps but it offers a clearer picture of the evolution than Gephi. Besides, the analysis shows that some words are more regular in the abstracts than others which are very ephemeral. For instance, the word design is present in all the volumes, the word collaboration is present in all the years but except one (2019) as the notion of support which is absent in 2015 only. The notion of building is present in 7 years out of 10. All the other notions come and go through the years and often at a low degree (perception, user, engagement, communication, institution ...). The evolution of the concepts and notions addressed by the researchers through the years is visible in the charter Figure 7.

The results of the AFC analysis are a good complement previous analyses presented above. We found that the main concepts and notions mentioned in the abstracts are a far cry from each other from one to another. In spite of this dispersion, we can notice that some background notions are common to some years. For example, the focal points in 2016, 2017, 2019 and 2020 are very similar while the notions which are prominent in the articles published

in 2018, 2012 and 2021 are very alike. The results show that during the years in in 2016, 2017, 2019 and 2020, “design, work and create” (among other words) were the most used in the abstracts while the words “library, faculty, center, learn and active” were the most mentioned in in 2018, 2012 and 2021. At the same time, the years 2013, 2014 and 2015 are at the extremities of the frame and have few significant words. Let’s now move the results of the Reinert analysis.

The Reinert analysis of the abstracts gave a dendrogram with 2 main classes with one that is divided into two subclasses. One of the subclasses is split into two other subclasses. One of the classes represents 98 % of the corpus and comprises three subclasses representing respectively (58%, 38% and 2%). The first subclass comprises the following notions given in order of frequency and importance: “Classroom, datum, student, perception, ungraduated, experience, difference, instructor, engagement ...”. Another subclass is composed of words such as “Library, technology, project, communication, practice, value, framework...” and verbs such as “analyze, find, develop”. The third class is formed with pragmatic concepts such as “book, review, topic, test, scholar, loss, gateway, architecture”. As far as the last class is concerned, it represents only 2% of the corpus and contains words referring to the methods and furniture: “tablet, arm, chair, table, seat, round, lecture, mobile, solution, work, movement ...). Once more, the notions mentioned in the abstracts are pretty disparate both in terms of number and in terms of area of study. We checked how the notions are present along the years through the abstracts with an analysis of the similarities.

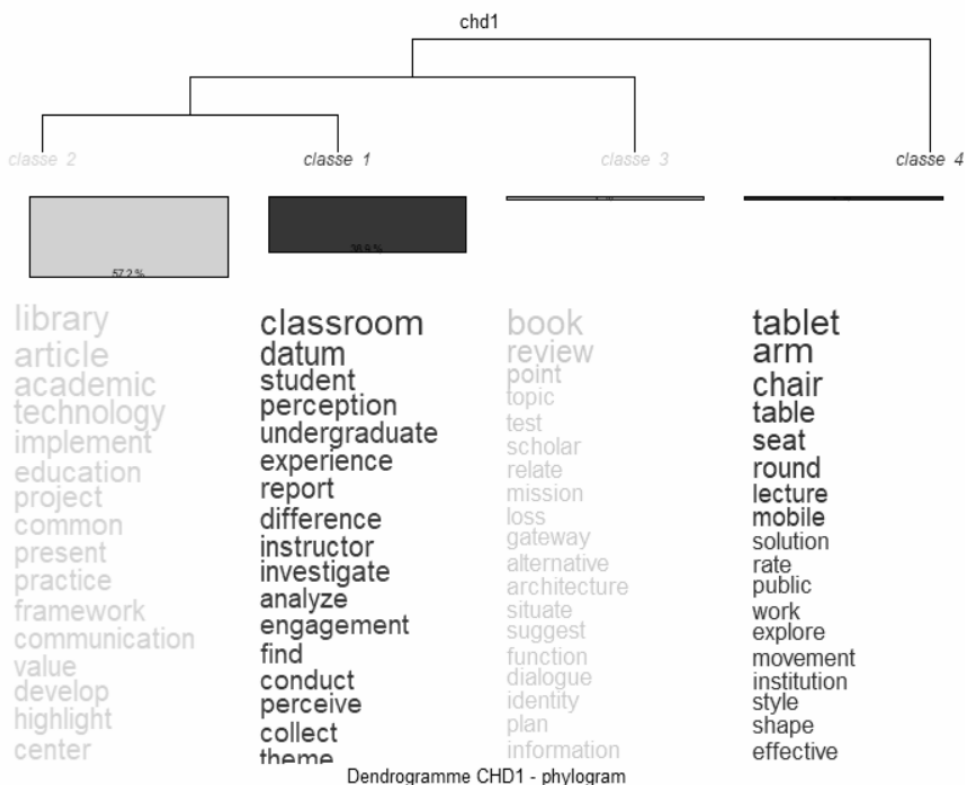


Figure 2 : Results of the Reinert analysis of the abstracts (JLS)

A similitude analysis was performed by setting the lowest number of occurrences at 5. Only three volumes (6,8 and 9) meet this condition. On the other hand, the main focal points (space,

learn and student) of these three volumes are strongly linked. Besides, the notion of “classroom, design and technology” are strongly linked to the notion “learn” in the 9 volume (2021) as shown in the screenshots below.

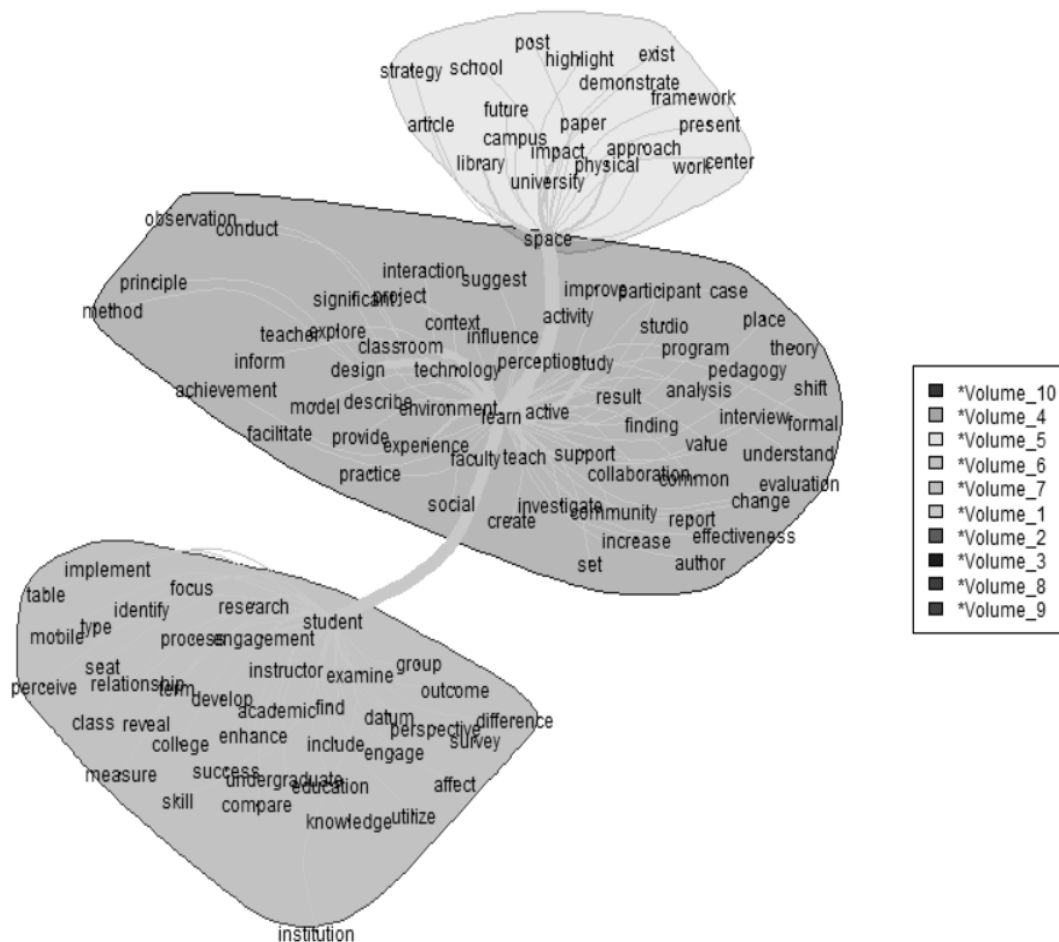


Figure 3 : Result of similitude analysis of the abstracts (JLS)

These new findings are very edifying on the concepts that are mostly addressed by the authors. Nonetheless, they are based on the metadata and the abstracts only. The result from the analysis using the whole text of the articles provided a further and deeper understanding of the evolution of the study of learning spaces.

The corpus containing the full articles was composed of 12888 occurrences, 1851 forms, 845 hapaxes (about 7% of the occurrences and 46 of the forms) with an average of 126 occurrences per article. The analysis of the specificities, as in the analysis with the abstracts, shows a heterogenous evolution of the prominent notions and concepts addressed by authors along the years. We are going to handpick the notions that provide the best view of this heterogeneity. For example, the word “architecture” had an index value of almost 2 in 2012 and 2013 but the value dropped to 0,71 in 2014 and -0,8 in 2017. In the same way, the word space had a value above or equal to 1 in 2012, 2015 and 2016 but the value fell to -5 in 2015. The word “collaboration” started with a value of nearly 4 in 2012 but narrowed kept shrinking

afterward and never reached 1 again in the following volumes. It is also striking to see that the notion of “design” is only significant in 2017 with an index value of 3,5. The Reinert analysis is a good means to have a further investigation on these findings.

The parameters applied to the analysis of the abstracts we replicated for the full texts of the article. The analysis resulted in an ontology of two classes one of which is cleaved forming two subclasses. One of the classes is divided into two subclasses. In this regard, the analysis of the abstracts and the one of the full texts gave similar results. Nevertheless, a quick observation makes you notice a first difference in the repartition of the components in the class groups. Indeed, one of the subclasses represents 98% of the notions. The subclass in question comprises words such as “student, learn, active, technology, engagement, impact, environment”. The other groups amount for less than 2% and contain words such as “book, review, table, board, display, class, movement, method, mobile furniture ...). The word architecture is found not being of a significant importance in the corpus.

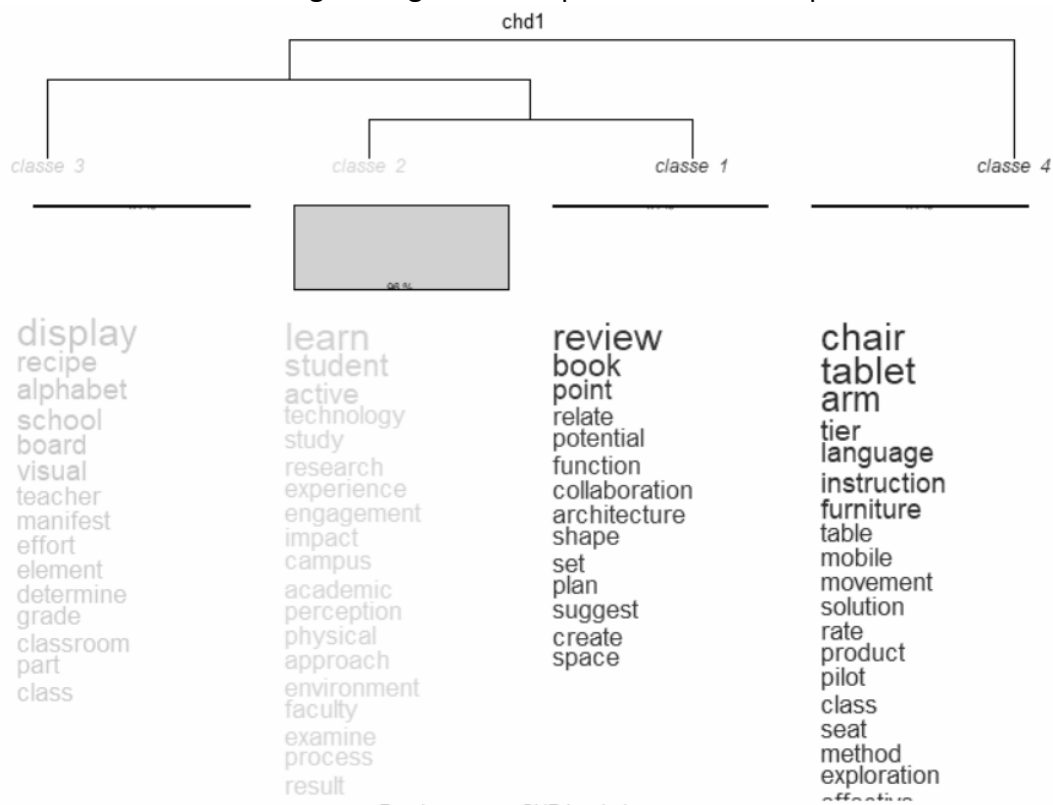


Figure 4 : Results of the Reinert analysis on full articles (JLS)

The AFC analysis showed more dissimilarities between the focal points from one year to another. Still, we can notice an important proximity/ affinity publication between the years 2016, 2017, 2018, 2019, 2020 and 2021. The zone where these years are clustered is also the zone where the words “learn, space, active, campus, university and social are located”. The other years have no significant “word” in terms of occurrence. Differently from the analysis of the abstracts the year 2012 is not isolated in the map. This analysis is very precious in understanding the dynamics in the publications but it still leaves some questions without answers such as which year is more decisive, how strong is the relation between the years. The analysis of the similarities is a valuable tool in trying to answer such questions.

We set the minimum index at 5 for a link to be represented. The analysis of the similarities showed only the publication of the years 2012, 2013, 2014, 2016, 2018 and 2021 has strong relations with at least the publications of another year. The strongest concept in the publication in 2018 is “student” while in 2020 it was “space” (and in 2014). The focus was on “study” or “studying” in 2015 (and 2014). The “design” (and in 2014) came to the forefront in 2021 and emerged as a major object of study. The most important finding is that 2014 has been a decisive year with the words “learn and classroom”. In addition, 2014 is related to all the other years in the analysis. It is also very important to spot that the words we’ve just mentioned are strongly related and used together by the researchers. We need to point out that apart from the main focal points identified just above, the notions addressed are totally independent and rather disconnected from one year to another.

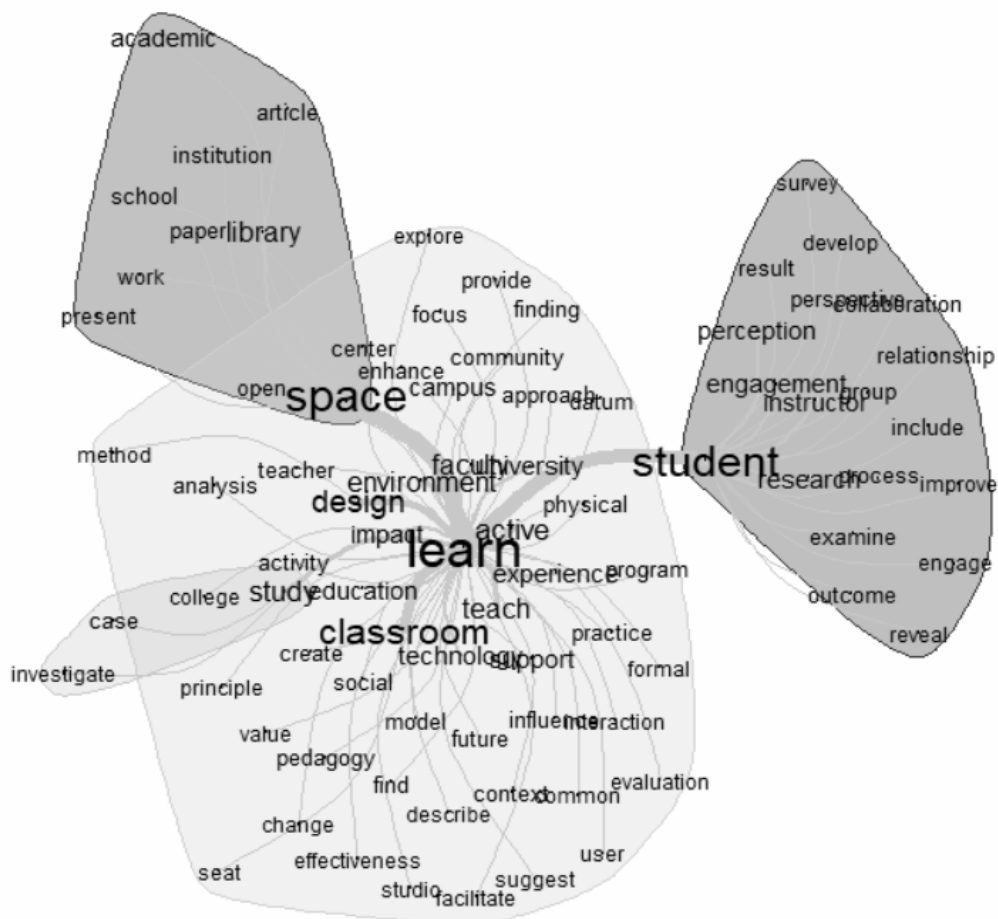


Figure 5 : The output of the similarities analysis on full articles

The analysis of the relations between the articles and the references was very helpful in our investigation. It allows us to see that the heterogeneity we observe in the notions and the vocabulary used by the researchers is also present within the references. Actually, we found only very few references that are quoted in more than one article.

The visualization of the relations between the articles and the references of the corpus was created with the articles from 2015 to 2021. The corpus was composed of 81 articles and 2477 references. We found that at least 220 references (near 9 %) were quoted in two articles at least. When we conducted an exploration of the visualization created with Gephi on a MAMP

online server, we identified the most quoted references. It is worth mentioning that the number of quotations of the references are quite low. Indeed, the most quoted reference we tracked is mentioned in only 6 publications. That reference is an article written by Brook (Brooks, 2012) and is quoted by the following authors Donnelly & Berry, 2019), Morieson et al., 2018, Parsons, 2018; Cogswell & Goudzwaard, 2018; Parsons, 2017 and Adedokun et al.; 2017). Thus, Brooks is the most quoted author in the publications of the journal. Another of his works (Brooks, 2011) is also quoted six times in other publications (Haines & Maurice-Takerei, 2019; Ramsay et al., 2017; Parsons, 2017; Adedokun et al., 2017) and Birdwell & Uttamchandani (2019). Likewise the article *“Matching instructors and spaces of learning: The impact of space on behavioral, affective and cognitive learning”* (McArthur, 2015) is mentioned in 4 articles (Ramsay et al., 2017; Parsons, 2017; Morieson et al., 2018; Cogswell & Goudzwaard, 2018). Besides, only very few references are quoted in more than three articles. Even if we have around 9 % of the references quoted in more than two works, rarely are they present in more than 2 publications.

Table 1 Some of the most quoted References

References	Quoted in
Brooks, D. C. (2011). Space matters: The impact of formal learning environments on student learning. <i>British Journal of Educational Technology</i> , 42(5), 719-726.	Haines & Maurice-Takerei (2019); Ramsay et al. (2017); Parsons (2017); Adedokun et al. (2017)
Brooks, D. C. (2012). Space and consequences: The impact of different formal learning spaces on instructor and student behavior. <i>Journal of Learning Spaces</i> , 1(2), Art. 2.	Donnelly & Berry (2019), Morieson et al. (2018), Parsons (2018), (Cogswell & Goudzwaard (2018), Parsons (2017) and (Adedokun et al. (2017).
McArthur, J. A. (2015). Matching Instructors and Spaces of Learning: The impact of classroom space on behavioral, affective and cognitive learning. <i>Journal of Learning Spaces</i> , 4(1), Art. 1.	Ramsay et al. (2017); Parsons (2017); Morieson et al. (2018); Cogswell & Goudzwaard (2018)
Rands, M. L. & Gansemer-Topf, A. M. (2017). The room itself is active: How classroom design impacts student engagement. <i>Journal of Learning Spaces</i> .	Haines & Maurice-Takerei (2019); Birdwell & Uttamchandani (2019)
McDavid, L., Parker, L. C., Burgess, W., Robertshaw, B., & Doan, T. (2018). The combined effect of learning space and faculty self-efficacy to use student-centered practices on teaching experiences and student engagement. <i>Journal of Learning Spaces</i> .	Haines & Maurice-Takerei (2019); Donnelly & Berry (2019)
Finkelstein, A., Ferris, J., Weston, C., & Winer, L. (2016). Research-informed principles for (Re)designing teaching and learning spaces. <i>Journal of Learning Spaces</i> .	McDavid et al. (2018); Donnelly & Berry (2019)
Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. <i>Educational Researcher</i> , 18(1).	Donnelly & Berry (2019); Birdwell & Uttamchandani (2019)
Leiboff, D. (2010, May 19). Studio classroom: Designing collaborative learning spaces. <i>Campus Technology</i> .	(Morieson et al., 2018) (Parsons, 2017) (Cogswell & Goudzwaard, 2018)

We visualized the link between the article with the highest number of link within each year from the debut of the journal upto now (2023) namely : (Chiu, 2016; Gatlin et al., 2021; Haines

& Maurice-Takerei, 2019; Harvey & Kenyon, 2013; Horne et al., 2012; McDavid et al., 2018; Rook et al., 2020; Schadl et al., 2015; Xi et al., 2017). The results show that these publications have no link as far as the authors and the references are concerned. The next step was to compare the variations et evolution of the notions dealt with in the publications in which the authors with the highest number of links were involved.

The most significant terms in Crumpton's work are "language", "book", "library", "project", "vision", "build" and "stakeholders" (index = from 15 to 6). As for McDonald the keywords from his corpus are "user", "policy", "individual", "community", "norm" (index: from 32 to 16). The most mentioned words in Milo Shussman's publications are "letter", "readability", "board", "alphabet", "visual", "characteristics", "display", "background", "color" and "font" (index from 190 to 29). Odum, as far as she is concerned, focuses on questions associated with words such as "engagement", "active", "instruction", "team", "renovate", "train" and "participant" (from: 42 to 10 repetitions). Parker on his side uses the following lexicon: "efficacy", "center", "space", "learn", "century", "practice", "faculty", "satisfaction", "student" and "active" (index: from 63 to 16). "Dialogue", "roundtable", "discussion", "technology", "classroom", "socialization" and "program" are at the top rung of the ladder for Parsons (index: 40 to 27). Eventually, Walker's works are directed towards notions in relation with terms including "social", "context", "dimension", "factor", "instructor", "relation" and "scale" (index: 48 to 50). This preliminary analysis shows that these authors have very different objects of study. Plus, there is very little interaction between works and authors.

## 5.2 OCDE

The prototypical analysis in Iramuteq shows that the most prominent and significant keyword is used in the corpus of the OCDE publications is "Education policy", followed by "modern schools", then "school architecture", "learning environment", "school conception", "innovative learning" and "adult learning". "School buildings" also appears as a prominent keyword for the people working with OECD.



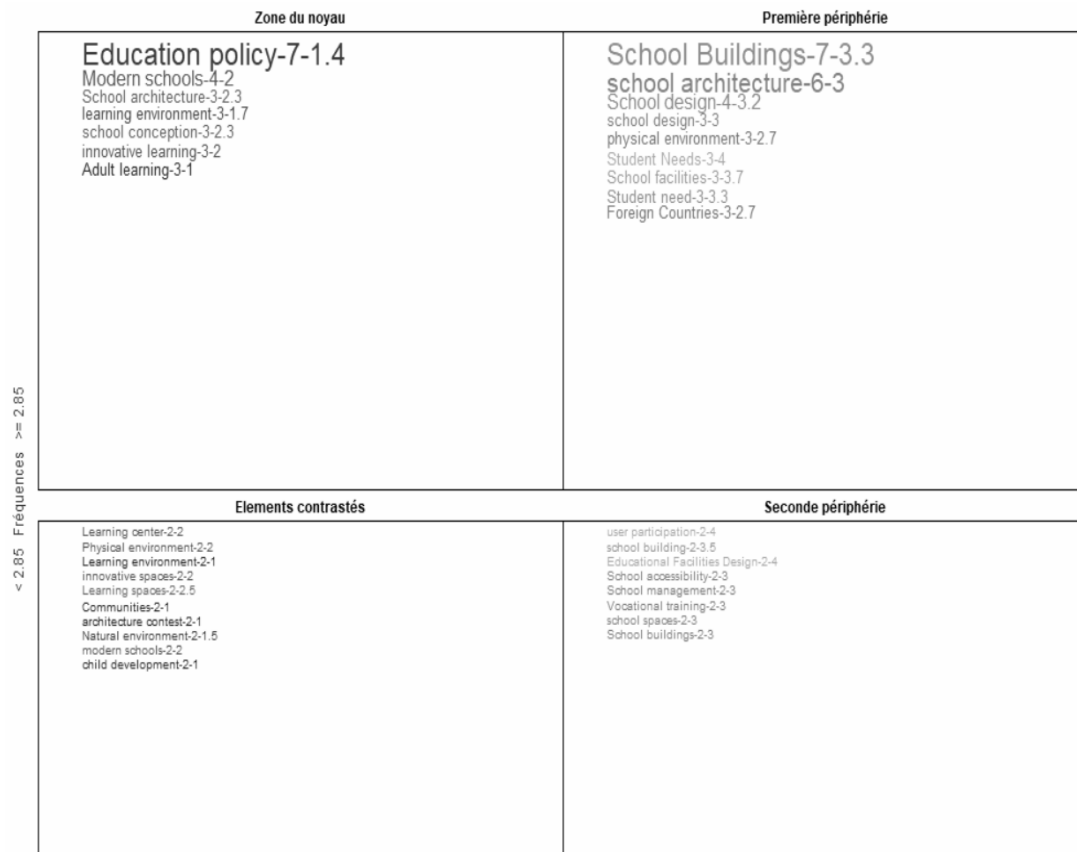


Figure 6 : Prototypical analysis of keywords (OECD)

The analysis of frequencies showed that the corpus contains 149 908 occurrences with 13 092 with an average of 2306 occurrences in each article. As for the output of the specificity analysis, it shows a remarkable disparity within the objects of study of the authors. In 1998 the most significant words were respectively *countries, building, planning, maintenance, capital, construction, area and user*. Concerning the year 1999, The most representative notions were *batiment, jury, collège, établissement, paysage, pédagogie, prix, client, école, qualité, architecte, couleur, and gestion*. As mentioned in the section exposing the method of this study, we used a bilingual corpus for this study. The words in the spotlight in 2000 included *campus, computer, user, meeting, staff, lecture, studio, institution, place, volume, location, étage, face and group*. A year later the focal shifted to words such as *scénario, avenir, marché, enseignement, enseignant, TIC, société, réseau, établissement, école, usager, changement et tendance*. In 2002, the focus was on the elements related to the classroom and training strategies with notions such as *élève, équipement, formation, école, salle, équipier, attente, bâtiment, atelier, exigence, acoustique, plafond, sport*. The pointer moved to concepts in relation with management and resources monitoring which is visible through the most prominent words such as *energy, gestion, consommation, population, eau, élaborer, réduire, projet, aménagement, économie and risque*. In 2004, some other scope of the studies became larger including elements that can be associated with schools after a fashion. Among them one can name *atelier, région, socialisation, bibliothèque, consultant and rencontre*. The next year will witness the emergence of concepts mostly referring to higher education among which are *recherche, université, séminaire and ministère*. In the publication of 2007, authors focused on the raw materials used by in the construction of schools: *mur, brique, béton, bois, énergie, défi and conception*. The object of study turned to questions in connection with early

childhood and pedagogic models with notions such as *enfant, modèle, jeu, échec, difficulté and échange*. The year 2009 is marked by publication on classroom stimuli and environment: green, noise, orange, sunlight, pale, air, stimulation, texture and perception. In 2010, the authors were interested in investigating issues at the local and regional level which put forward the following words: centre, département, utilisateur, prix and cluster, communauté. 2011 is the last publication year of the corpus we studied and the researches, then, were rather fuzzy with no specific focal for one can't spot a precise focal point. Actually, the most prominent notions were: process, group, model, user, relation, stage, challenge, concept, goal and performance.

The AFC analysis of the publications in English shows a predominance of the policy and the physical setting of the learning spaces. In addition, those two spheres are not interlinked. On the contrary they are very distant from one another. This suggests that these two areas are investigated separately by the researchers. In the sphere corresponding to the year 1998 the words "Planner" and "cost" are the most important while in the sphere corresponding to the year 2009 the words "window" and "color" are predominant while the year 2010 focuses on the term's "type" and "programme".

The same analysis with the countries as the independent variable shows that studies carried out in the UK and in Germany contain more regular notion along the years than articles from other countries. For instance, the sphere where the UK is located appears to emphasize questions related to the natural environment and the physical setting treating issues such as color, the furniture and natural lighting. The publications from Germany and transnational works share some objects of study with the UK but are mainly focused on the "policy".

The Analysis of Reinert on the publications in English gave a graphic with two main stems with two classes. Then, one of the classes is divided into 2. One subclass represents more than 50 % of the repartition with terms such as "school", "learn", "design", "facility", "student", "education", "teach", "project", "need", "community", "teacher", "space", "building", and "environment". The second subclass represents more than 10 % and contains words related to the physical settings and the natural environment of learning spaces: "window", "heat", "daylight", "light", "air", "area", "room", "glaze", "east", "wall", "south", "solar", "north", and "noise". The third subclass is composed of colors and their nuances. It weighs less than 5 %.

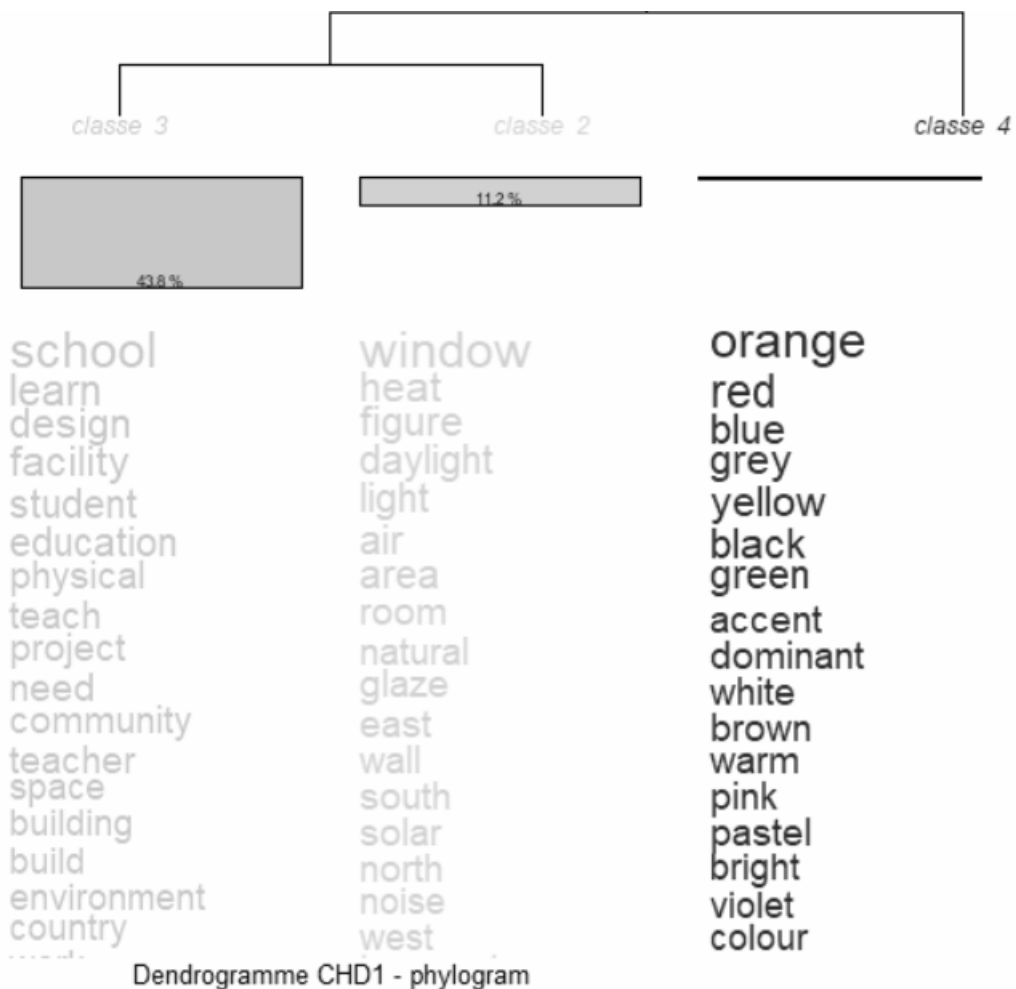


Figure 7 : Reinert analysis of full articles (OECD)

The analysis of similarities of the corpus with publications in English shows that the year 1998 contains most of the significant words in terms of use. The year 2010 comes in the second place. Along with this observation, it is important to notice that these two years do not have any strong links while the most prominent concepts in 1999 and 2009 are not present in publications between 1999 and 2009. This suggests that the concepts<sup>10</sup> emerged again after they were left aside for some years. It is also interesting to note that the majority of the most representative terms are from publications written by transnational research teams. The other most significant terms from a single country are from European countries.

<sup>10</sup> size, performance, architecture, planning

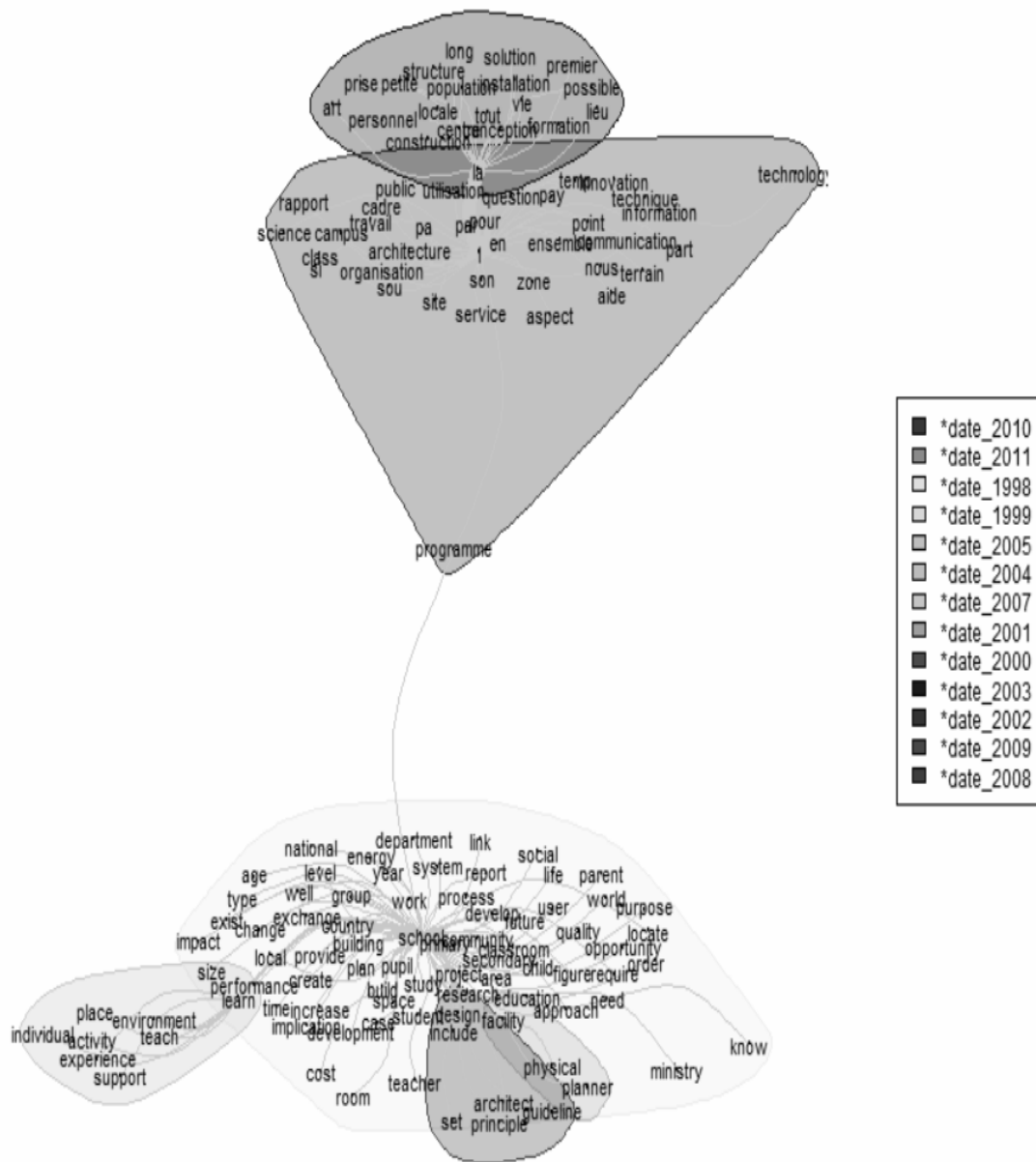


Figure 8 : Analysis of similarities of English publication (OECD)

As far as the publications written in French are concerned, the analysis displays a bipolar visual dominated by terms from 1998 and 2005. These two poles are very similar. Some important words in 1998 emerged again in 2007 after having disappeared for many years.

The same analysis using the countries as variables also shows a bipolar graphic bound by the term “construction”. Thus, the word “construction” seems to be, at the same time, a turning point and a contact point for the publication. Indeed, it means that the term is associated with the other significant terms in all major publications.

The analysis of Reinert classified the terms from the French corpus in two groups. The first group contains, in majority, terms which express concepts located at the micro level such as “salle, classe, espace, mur, étage, jardin, couleur etc”. As of the second class, it focuses on the

actors and the meso level “école, projet, conception, environnement, bâtiment, communauté, élève etc”.



Figure 9 : Reinert analysis of publications in French (OECD)

The results of the visualization of the links between the articles through the keywords gave very heterogeneous levels of connection. Moreover, the number of articles using the exact keywords are very few. For instance, the most shared keyword (*school building*) is present in eleven articles<sup>11</sup> only. The word *education policy* is present in 8 articles. The words *modern schools* and *school design* are used 7 times each. The keyword *student need* has 6 connections. *Learning environment* is used as a keyword in 5 articles. The keywords *learning spaces* are used in not more than 2 articles while *school management* is mentioned in the keywords of 3 articles. It is also interesting to note that only Ponti and Fisher have contributed in more than 2 articles about the question of school buildings.

<sup>11</sup> (Comely, 2002), (Ponti, 2005), (Rigolon, 2010), (Robinson & Robinson, 2009), (Ponti, 2009), (Wilson, 2003), (Kavaja, 1999), (Scottish Executive, 2004), (Beynon, 1997), (OCDE, 1999), (Jorge & da Costa, 2011)



Figure 10 : Visualization of the relation between articles through keywords with Gephi (OECD)

## 6. CONCLUSION AND PERSPECTIVES

Regarding the JLS, the results of the preliminary study suggest a very high disparity in the terminology used by the authors and the steadiness of works in the field. This founding shows the need for the research community to agree on common terms and develop more collaborative works to ensure a form of regularity and stability in the field. This important and critical move appears to be achievable given that the terms used are sometimes not very different in meaning. In fact, the unsteadiness of the object of study along the years could be mitigated with more cross-field and within-discipline collaboration. For instance, the evolution of the notion of “design” and “building” reveals to be very fluttering in the works. It is difficult to make out any established approach or notion as they all wax and wane from one year to another. Along with this, there is also a need for more long-term research to build consistent knowledge. In other words, while the need to cover a wide range of questions is undeniable, there must be conventional approach or area which serves a beacon in this still uncharted territory. Despite this observation, we need to acknowledge the existence of distinct categories of variables ranging from the physical settings, human senses, pedagogical material ... This almost natural classification can be used as the raw material from which to extract the leading concepts and even create a taxonomy, come to that. Another key element is the fact that there is no work which stands as a widely shared reference or author who can be considered as the undisputed leader of this movement. This, also, is a hindrance in the process of steadying the object of study. But this doesn't mean that there is no high-profile publications and authors in the field. However, the need is still there for a supremo or at least a set of works regarded as the pioneers and founding theories.

Taking a stance opposite to the one of the JLS, the prominent keywords of the publications by the OECD are more policy-centered “Education policy”, followed by “modern schools” even if, as the one of the JLS, they address issues related to space, design and architecture. As they

share some areas of interest these publications also share a remarkable disparity in their focuses from one author to another and from one year to the other. Once again, a more cross-discipline and cross-sector approach is the key to more proficient and cost-effective research both for the research institutions and the state-run organizations. The necessity of bringing together researchers and policy decision makers to the table is a matter of the utmost importance in an on-the-making areas such as school architecture and learning spaces design.

Table 2 : Table of the results of the review

JLS			
Analysis	Observations	Details	Remark/comment
Relation between tags and authors	No strong communities / a remarkable disparity	use of different terminology	some tags are close in meaning "active learning classrooms" (used in 2 articles), "active learning space"
Relation between authors, years and articles	very few of them are related / a remarkable disparity	notions wax and wane along the years and the authors	Parsons is the most quoted author (in 12 articles). He contributed in 3 articles.
Bibliographies	Few quotations between the authors	No established authority	220 references (near 9 %) were quoted in at least two articles. The most quoted is mentioned in only 6 publications (Brooks, 2012)
OECD			
Keywords analysis	policy-centered	a wide range of preoccupations	"Education policy", followed by "modern schools", then "school architecture", "learning environment", "school conception", "innovative learning" and "adult learning". "School buildings"
Analyses of the evolution of keywords	A remarkable disparity	notions and variables are very disparate	change of focus according to the years, authors and countries

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**8. ANNEXES**

Arcles	Date	Volume	-*them_ID_ART	Resume
****Article1	*date_2021	*Volume_10	-*them_2021_10_2_1	The physical space of campus may

Annex 1 : Preparation of the google-sheet for iramuteq analysis)

Key	Keywords	N_Keyword1	N_Keyword2	N_Keyword3
CXU54SF8	models	1	early childhood	2
VHRIM799	design features	1	future	2

Annex 2 : Information available in the metadata section of the visualisation (nodes)

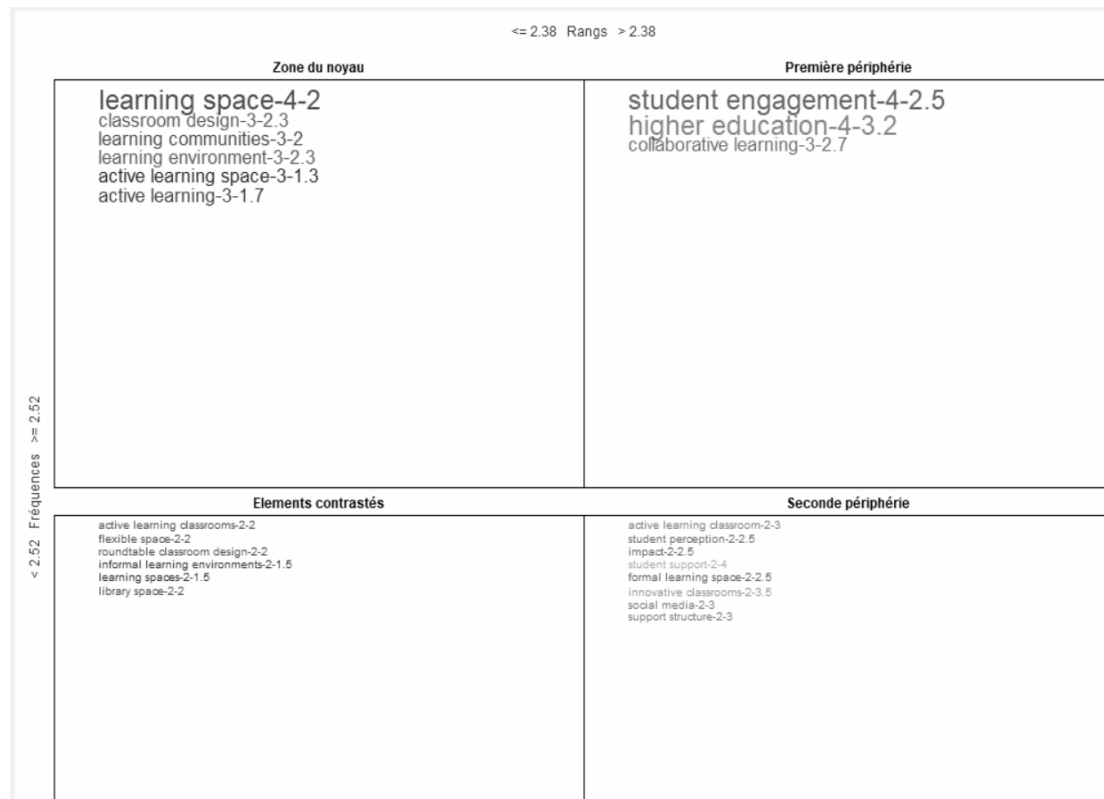
Source	Target	Type
2002_30_DD	1000	Undirected

Annex 3 : Screenshot of the edges table



Annex 42 : Visualisation of the links between articles, tags and authors (JLS)

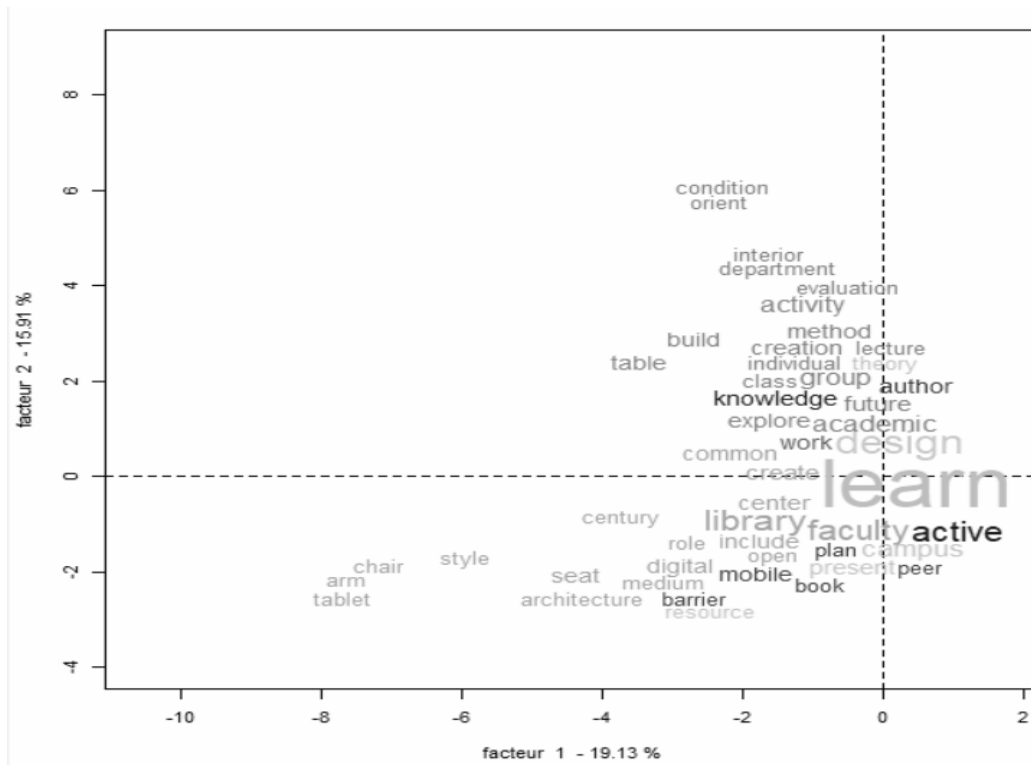




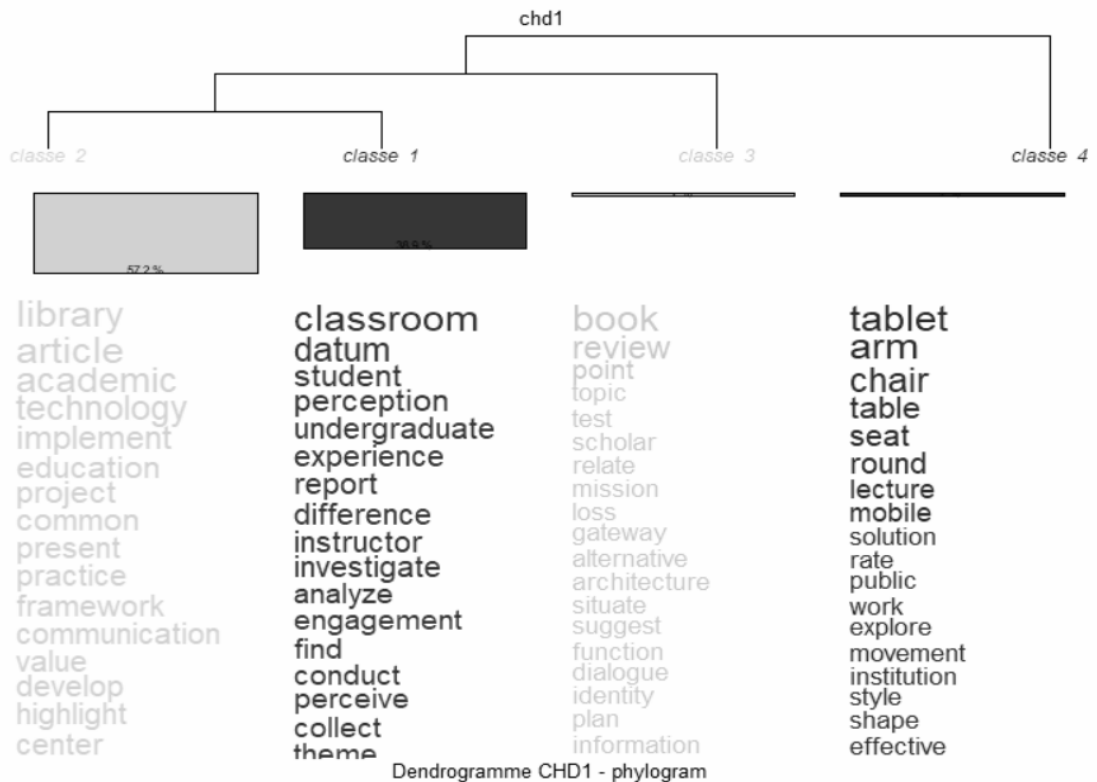
Annex 5 : Results of the prototypical analysis (JLS)

formes	*date_2012	*date_2013	*date_2014	*date_2015	*date_2016	*date_2017	*date_2018	*date_2019	*date_2020	*date_2021
process	1.1683	-0.4028	-0.3759	-0.2777	0.4433	-0.3013	0.7286	-0.1959	-0.2925	-0.3995
not	1.0193	-0.2202	-0.4775	-0.1519	0.2876	0.9246	-0.1967	-0.1755	-0.2416	-0.4974
campus	0.825	-0.5669	-1.2293	5.0512	-0.2394	-2.4645	0.682	-0.749	-1.7155	2.4293
design	0.8143	-0.2582	0.3659	-0.2414	-0.4257	3.5604	-0.3131	-0.8198	-1.2824	-1.3564
article	0.6307	0.2325	-0.3472	0.3419	-0.3658	0.6072	-0.4685	0.8669	-0.5662	-0.3691
support	0.5977	0.2186	-0.3759	-0.2777	0.7602	-0.5685	0.3914	-0.456	-0.2925	0.5049
are	0.5553	-0.7744	0.5445	-0.5339	-0.5368	0.2644	-0.2549	-0.393	0.6783	0.5023
user	0.4192	0.9383	0.3201	-0.3766	-0.2154	0.2562	0.4275	0.488	-0.9399	-0.6263
haver	0.3199	-0.2606	-0.1885	-0.1797	0.9199	-0.5396	-0.6916	0.3837	0.2862	0.431
perspective	0.2972	-0.2809	-0.6089	-0.1937	-0.4589	1.5788	0.3107	0.3449	-0.3555	-0.2272
case	0.2579	-0.3214	-0.2646	1.0688	-0.2576	-0.3697	1.0021	-0.794	-0.1824	0.3212
four	0.2579	-0.3214	1.8997	-0.2216	-0.2576	-0.3697	1.0021	-0.3231	-0.4371	-0.7258
dater	0.1975	-0.4028	0.5357	-0.2777	-0.4047	-0.5685	0.3914	-0.9951	0.5973	1.4156
impact	-0.1716	-0.4846	-1.0509	-0.3341	0.5323	-0.7905	0.5361	-1.1974	2.1283	0.6927
by	-0.1946	-0.3972	0.9532	-0.6206	0.2905	1.4176	0.4091	-1.4055	-0.5168	-0.4507
interaction	-0.2172	-0.2001	0.1995	-0.138	0.3345	0.2493	-0.5309	0.5363	0.8925	-0.4519
communication	-0.2172	-0.2001	-0.4338	0.5652	0.3345	-0.8691	-0.1676	2.6894	-0.2064	-0.4519
studio	-0.2172	-0.2001	-0.4338	-0.138	1.2947	-0.3598	-0.5309	-0.4943	2.3122	-0.4519
mobile	-0.2391	1.9734	-0.4775	0.53	-0.3149	-0.9567	-0.5844	-0.544	0.3698	1.7774
participant	-0.2391	-0.2202	-0.4775	-0.1519	0.2876	-0.4179	-0.5844	0.9845	2.0956	-0.4974
changer	-0.2391	1.08	-0.4775	-0.1519	0.2876	0.209	-0.1967	-0.1755	-0.2416	0.5299
table	-0.261	1.862	3.4641	-0.1658	-0.8641	-1.0444	-0.638	-0.5939	-0.2783	0.4773
influence	-0.2829	-0.2606	-0.5651	-0.1797	1.4623	0.3718	0.7489	-0.6438	-0.3163	-0.2011
building	-0.2829	0.9525	3.229	-0.1797	-0.4095	-0.5396	-0.2589	-0.2316	-0.7884	-0.2011
for	-0.2959	0.6095	-0.3349	0.8745	-0.3943	-0.7	-0.368	1.3043	-0.3319	-0.3922
examiner	-0.3049	0.3222	-0.2131	0.444	-0.1933	-0.6029	1.1848	0.3449	-0.3555	-0.2272
institution	-0.3489	0.8015	-0.2646	-0.2216	-1.1553	0.4908	0.2492	0.6199	0.4648	-0.2818
model	-0.3489	0.2816	-0.2646	-0.2216	-0.2576	0.2418	0.5628	0.6199	-0.4371	0.3212
valoir	-0.3489	-0.3214	-0.6969	1.0688	1.6279	0.2418	-0.3599	0.6199	-0.9723	-0.2818
about	-0.4151	0.2325	-0.3472	-0.2637	0.4907	0.3399	-1.0149	1.3642	0.3425	-0.3691
course	-0.4372	-0.4028	-0.3759	-0.2777	-0.7779	1.2849	-1.069	1.2765	0.5973	0.2208
perception	-0.5038	0.5602	-1.0064	0.2829	-0.9485	-0.4196	-0.6226	1.051	1.1901	0.7401
group	-0.5929	-0.1826	2.6511	-0.3766	0.4077	0.4472	-0.7853	-0.7108	0.3274	-0.6263
engagement	-0.7501	-0.2653	-0.8251	-0.4764	-0.406	-0.2338	1.0846	-0.5619	0.8625	0.9718

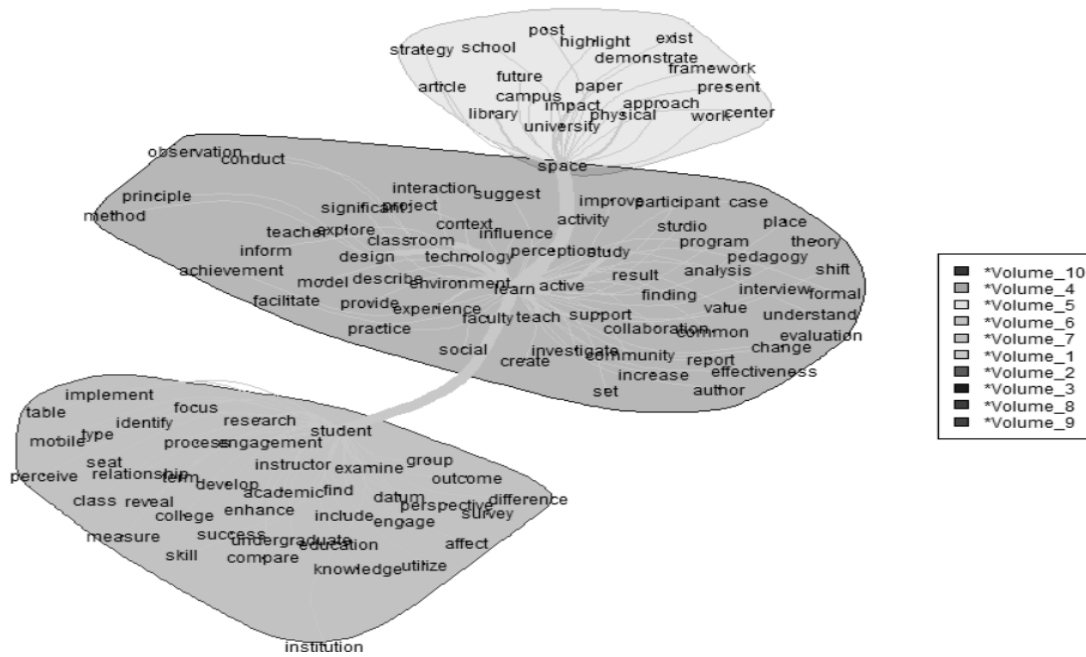
Annex 6: The evolution of the concept and notions in the abstracts JLS publications



Annex 7 : AFC analysis showing the proximity of concepts according to the year (JLS)



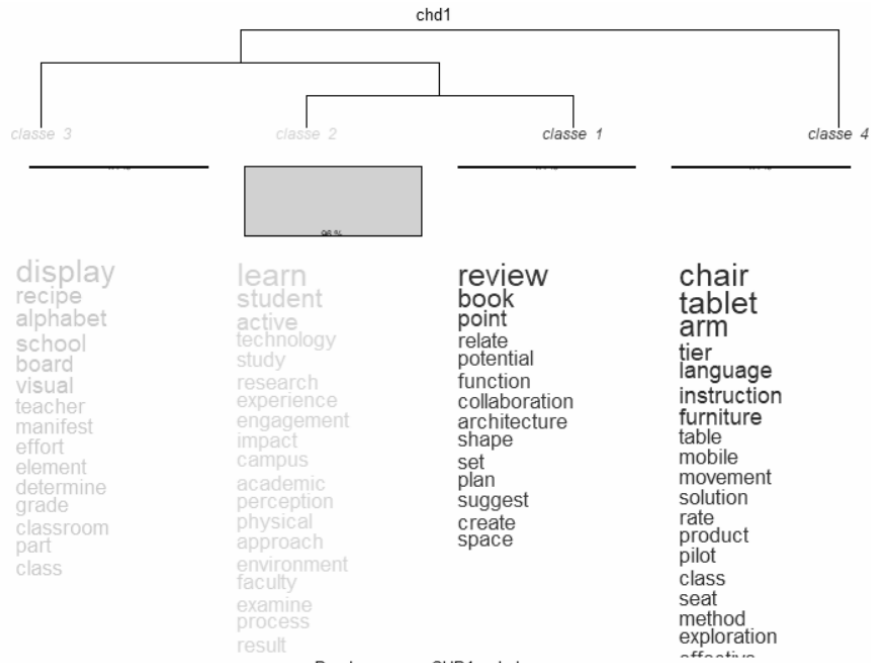
Annex 8 : Results of the Reinert analysis of the abstracts (JLS)



Annex 9 : Result of similitude analysis of the abstracts (JLS)

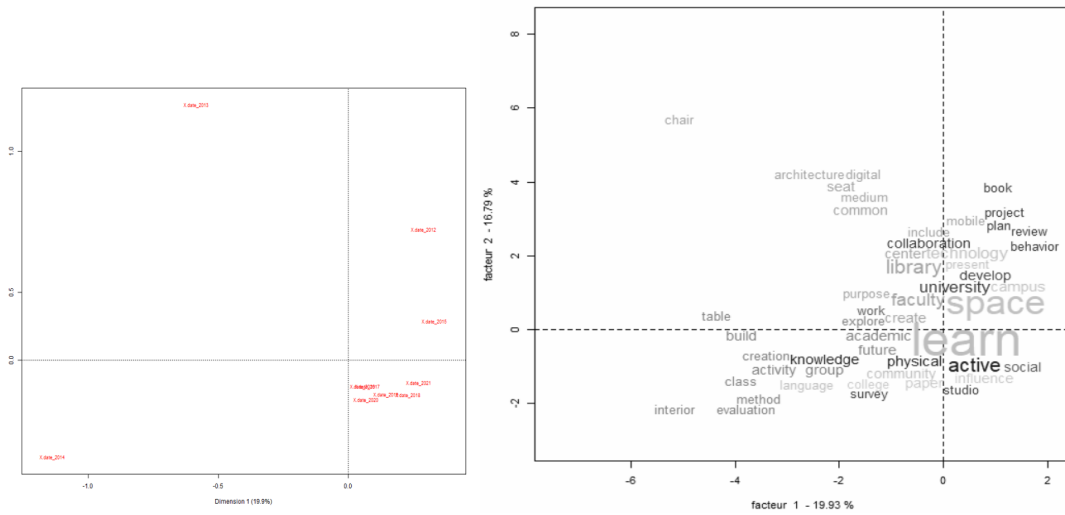
formes	*date_2012	*date_2013	*date_2014	*date_2015	*date_2016	*date_2017	*date_2018	*date_2019	*date_2020	*date_2021
project	5.4674	0.259	-0.5147	-0.1707	-0.4937	-0.2531	-0.2906	-0.6768	0.2186	-0.589
review	5.3469	-0.2482	-0.3675	-0.1218	0.3097	-0.3311	-0.5164	-0.4832	-0.2362	-0.4205
behavior	5.0249	-0.273	-0.4043	-0.134	1.0785	-0.9017	-0.5681	-0.5316	-0.2758	-0.4626
book	4.0171	0.3612	-0.3675	0.6115	-0.2925	-0.8196	-0.5164	0.5466	-0.657	-0.4205
collaboration	3.7995	0.4345	0.5455	0.3224	0.2912	-1.1246	-0.2877	-1.113	-0.4501	-0.4438
plan	3.5594	0.3042	-0.4411	0.5438	-0.3901	-0.4401	-0.6198	-0.58	-0.3169	0.5157
information	2.8446	0.3612	-0.3675	-0.1218	-0.2925	-0.3311	-0.1615	-0.4832	0.3772	-0.4205
university	2.1643	0.8706	0.3941	-0.3225	-0.3565	0.5552	-1.1801	0.3015	-0.6992	-0.8118
architecture	1.8228	1.8196	0.7172	-0.1218	-0.7551	-0.8196	-0.5164	-0.4832	0.3772	-0.4205
author	1.7122	-0.273	1.2721	-0.134	-0.3405	-0.9017	-0.1896	-0.1706	0.3278	-0.4626
instructor	1.5462	-1.0708	-0.902	-0.5258	1.8669	0.3332	-0.3336	-1.2996	-0.3692	0.4393
space	1.5266	-0.6216	-4.1099	1.8389	1.5415	-0.3445	0.3569	0.5319	-1.1902	-0.4148
technology	1.4574	1.9029	-0.8314	2.3421	-0.7597	0.5759	-0.4288	-0.3601	-0.7704	1.5727
formal	1.3419	-0.3724	-0.5516	-0.1829	-0.2494	-0.6149	-0.3129	-0.7252	1.9178	0.3885
campus	1.183	-0.4682	-1.4748	8.2544	-0.434	-1.6595	1.1432	-0.7165	-1.7568	0.5129
perspective	1.1404	-0.4471	-0.6621	-0.2195	-0.7142	1.1336	0.8721	0.2373	-0.5872	-0.305
common	1.083	3.3921	0.3341	-0.2317	1.1634	-0.8634	-0.9821	-0.919	-0.6354	-0.7998
informal	1.0296	-0.4968	0.3092	-0.2439	1.0685	0.5999	0.407	-0.9675	-1.3155	-0.3591
demonstrate	0.9961	-0.2482	-0.3675	-0.1218	-0.2925	0.6213	-0.5164	0.5466	0.3772	-0.4205
inform	0.9961	-0.2482	0.2434	-0.1218	0.3097	-0.3311	-0.5164	-0.4832	0.3772	0.6312
promote	0.9961	-0.2482	-0.3675	-0.1218	-0.2925	0.2729	0.5078	-0.4832	-0.657	1.2424
large	0.9244	-0.273	-0.4043	-0.134	0.2648	-0.3848	-0.5681	-0.1706	0.3278	1.1339
describe	0.8033	-0.3227	0.5457	0.5147	1.3663	-1.0659	-0.2492	0.3935	-0.8544	-0.5469
process	0.7592	-0.6712	-0.4631	-0.3296	1.2686	-0.532	1.1329	-0.3484	-0.334	-0.5625
design	0.7148	-0.6137	1.1553	-0.3052	-0.4571	3.5078	0.2754	-0.6141	-2.5856	-1.178
theme_resume	0.7089	0.4725	-0.257	0.2677	-0.2696	-0.3948	-0.3992	0.4133	-0.3762	-0.2747
theme_mots_cles	0.7089	0.4725	-0.257	0.2677	-0.2696	-0.3948	-0.3992	0.4133	-0.3762	-0.2747
theme Titre	0.7089	0.4725	-0.257	0.2677	-0.2696	-0.3948	-0.3992	0.4133	-0.3762	-0.2747
suggest	0.7046	-0.3724	0.4604	-0.1829	1.1162	-0.2922	-0.3129	0.32	-0.4476	-0.6311
activity	0.6759	-0.7211	7.9747	-0.3541	-0.8656	0.2415	-1.5007	-0.7577	-0.3934	-0.6239
article	0.5525	-0.1455	-0.2703	0.3855	-0.402	0.6637	-0.4498	0.8802	-0.6354	-0.3318
support	0.5215	-0.3835	-0.6758	-0.4276	0.7366	-0.3691	1.0495	-0.5661	-0.3529	0.3915
academic	0.4598	-0.4339	2.5691	0.5482	0.3941	-1.5253	-1.9684	0.6889	-0.2565	-0.2755
context	0.4174	0.4113	-0.3881	-0.2929	-1.0686	1.8516	3.1425	-1.1615	-1.5793	-1.0108

Annex 10 : Evolution of the notions studied along the years full articles (JLS)

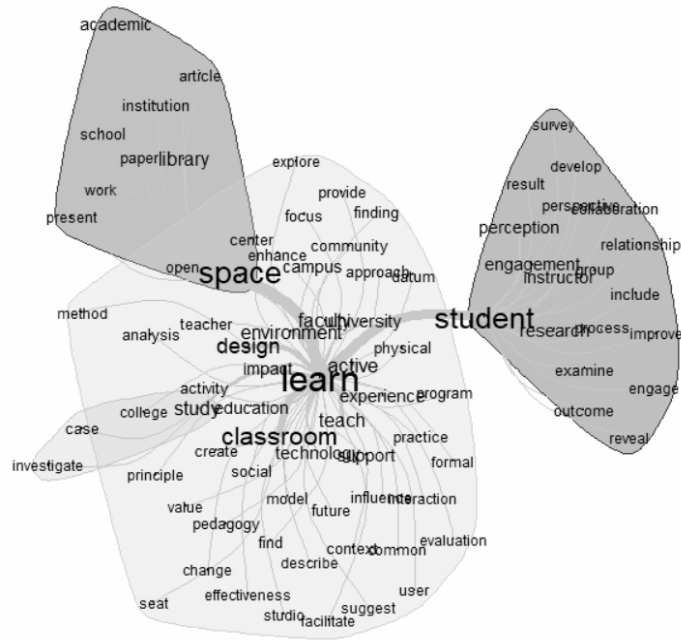


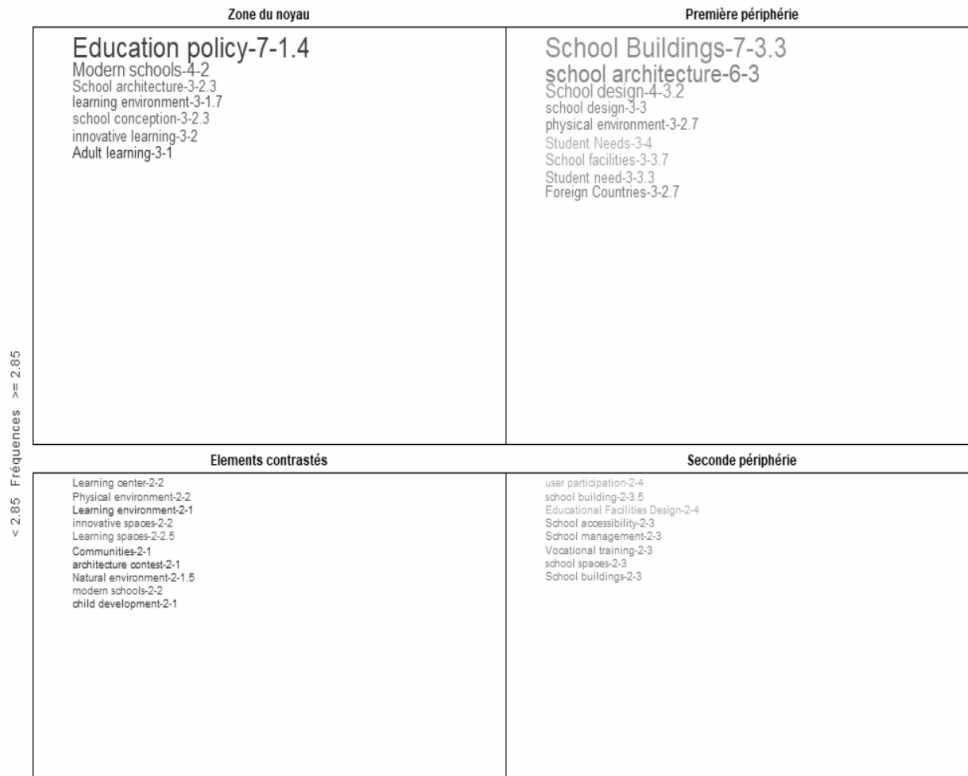
Dendrogramme CHD1 - phylogram

Annex 11 : Results of the Reinert analysis on full articles (JLS)

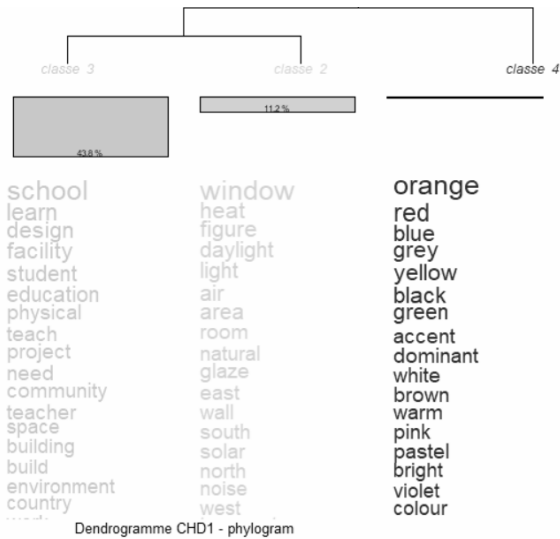


Annex 12 : Results of AFC analysis on full articles (JLS)

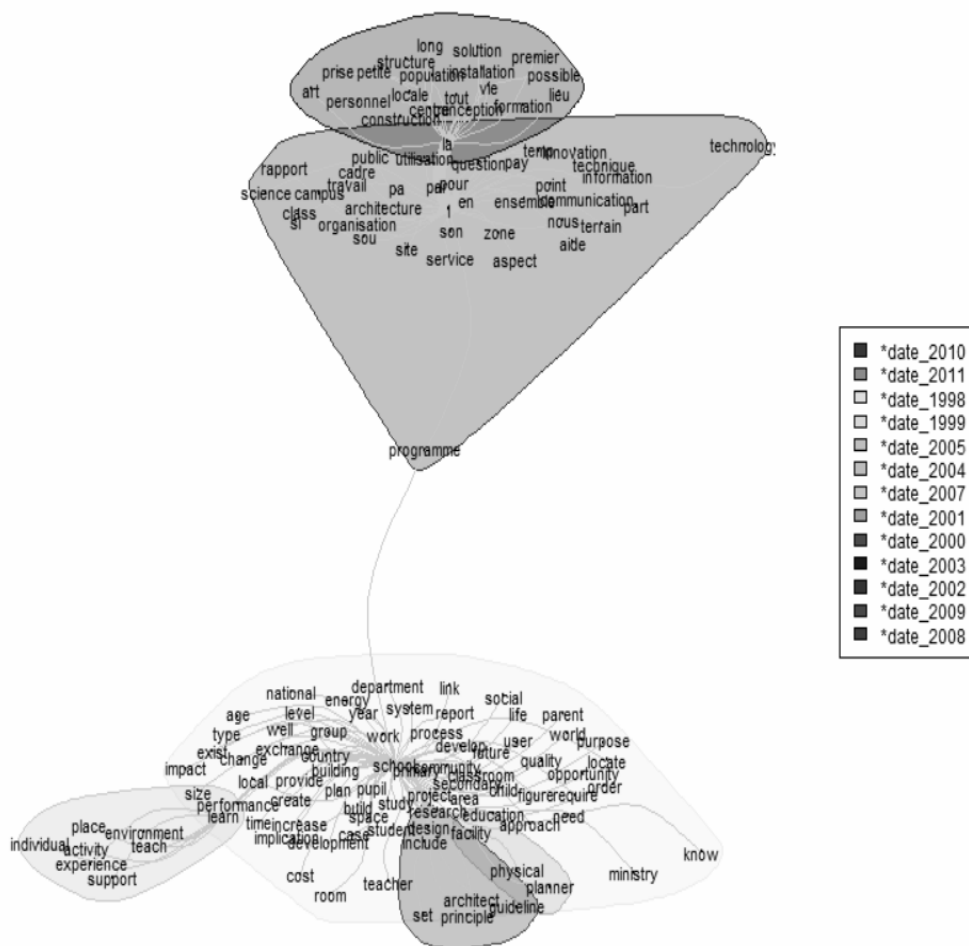




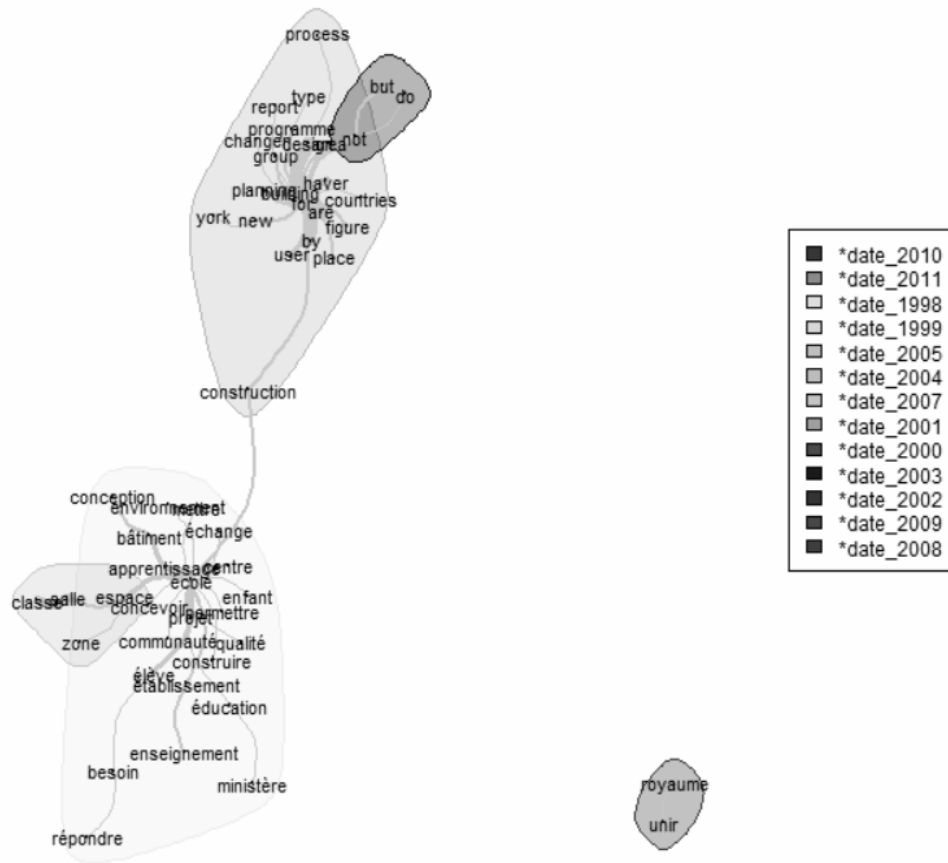
Annex 15 : Prototypical analysis of keywords (OECD)



Annex 16 : Reinert analysis of full articles (OECD)



Annex 17 : Analysis of similarities of the publication in English (OECD)

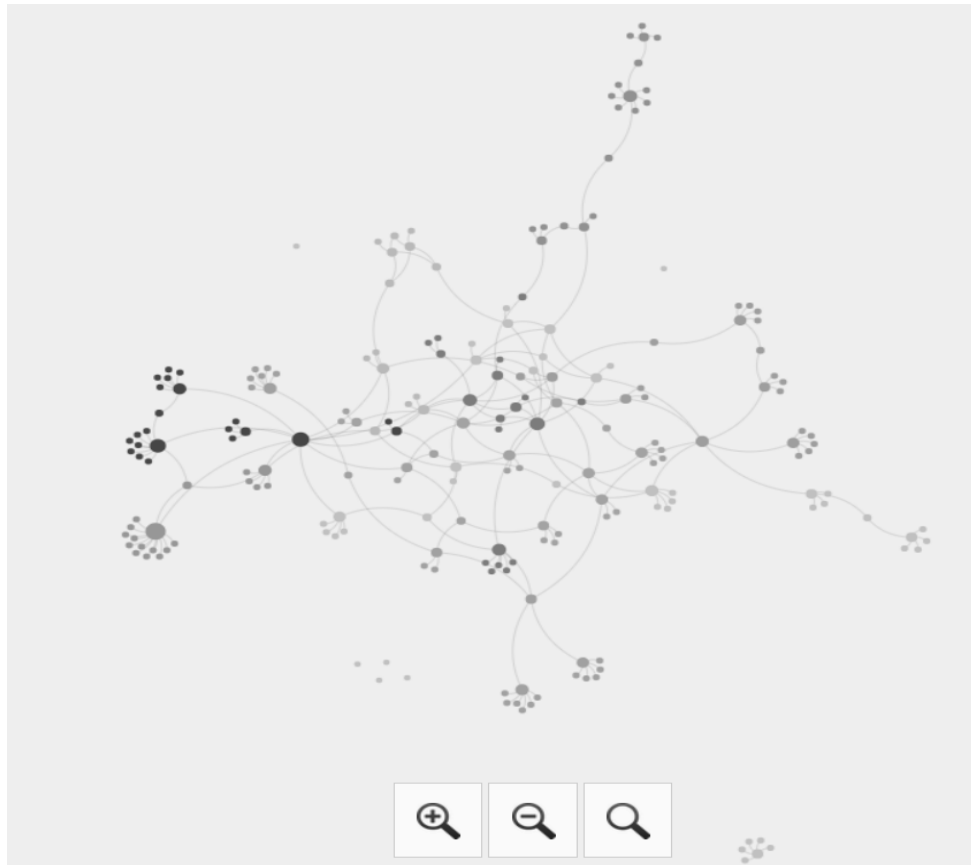


Annex 18 : Analysis of similarities the publications in French (OECD)



Annex 19 : Reinert analysis of publications in French (OECD)





Annex 20 : Visualization of the relation between articles through keywords with Gephi (OECD)

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