

The Future Classroom Lab. Educational considerations from a systematic review

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ABSTRACT

The irruption of technological tools and digital applications pose a challenge for educational centres that must adapt their methodologies, spaces and teacher training to meet the demands of the development of student competences in the 21st century. This research focuses on the transformation of educational spaces, specifically on the Future Classroom Lab (FCL) project, which since its inception in 2012 by the European Schoolnet (EUN) has not had a systematic review process of the scientific literature. The study method is based on a systematic review from the Web of Science and Scopus databases. The statistical programme Vosviewer was used to make the network map of terms. The results found were 19 manuscripts from 2012 to 2023, where Spain is the country with the most research on FCL. Technology is the most prominent term, after education and Future Classroom. The conclusions from the results obtained were that there is little scientific evidence on FCL in the 12 years analysed, although these spaces generate motivation among teachers and students, but there are also criticisms for this type of spaces that serve as a reflection and are discussed.

KEYWORDS

Future Classroom Lab, spaces, innovation, ICT, active methodologies

RÉSUMÉ

L'irruption des outils technologiques et des applications numériques constitue un défi pour les centres éducatifs qui doivent adapter leurs méthodologies, leurs espaces et la formation des enseignants pour répondre aux exigences du développement des compétences des élèves au XXI^e siècle. Cette recherche se concentre sur la transformation des espaces éducatifs, en particulier sur le projet Future Classroom

Lab (FCL) qui, depuis son lancement en 2012 par l'European Schoolnet (EUN), n'a pas fait l'objet d'un processus d'examen systématique de la littérature scientifique. La méthode d'étude est basée sur une revue systématique des bases de données Web of Science et Scopus. Le programme statistique Vosviewer a été utilisé pour cartographier le réseau de termes. Les résultats trouvés sont 19 manuscrits de 2012 à 2023, où l'Espagne est le pays où il y a le plus de recherches sur l'FCL. La technologie est le terme le plus important, après l'éducation et la salle de classe du futur. Les conclusions des résultats obtenus sont qu'il y a peu de preuves scientifiques sur l'FCL dans les 12 années analysées, bien que ces espaces génèrent de la motivation parmi les enseignants et les étudiants, mais il y a aussi des critiques pour ce type d'espaces qui servent de réflexion et sont discutées.

MOTS-CLÉS

Future Classroom Lab, spaces, innovation, TIC, méthodologies actives

Cite this article

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INTRODUCTION

Throughout the last decades, various educational paradigms have emerged that have had to adapt to changes according to the demands of society (Espíndola & Granillo, 2021). Research in educational innovation typically focuses on the role of teachers' educational practices, on a technological tool, on output performance or motivation, that is, teacher-initiated classroom interactions (Nurmi & Kiuru, 2015). However, the transformation of educational spaces, along with technological use and development is a current trend and concern for many institutions (OECD, 2018) because little has changed in conventional classrooms (Atif, 2013). These changes present new challenges that require teacher training (Lau & Jong, 2023; Lessard et al., 2015) in active methodologies and digital competence in innovative spaces with the difficulty of requiring costly resources.

One of the most didactically relevant proposals in the field of education is the Future Classroom Lab (FCL) (González-Pérez et al., 2022). For this reason, this study analyses through a systematic review of the scientific literature, the e project FCL promoted by the European Schoolnet since 2012 as an educational model adapted to the development of students' key competences of the European Union, as opposed to the traditional teaching model.

THEORETICAL FRAMEWORK

The need for educational innovation compared to the traditional method

The FCL is a European educational project that was born in 2012 and was driven by the European Schoolnet (EUN). It was led by a network of 34 ministries of education across Europe. The FCL builds on the research results of the iTEC project, funded by the European Commission (Blahová et al., 2013) to develop attractive scenarios that can be validated on a large scale and subsequently expanded. The initial impact of the project was obtained by pilot testing in more than 2000 classrooms in 17 countries, with an emphasis on science and mathematics at the secondary school stage (Jørund, 2012).

At the beginning of the 20th century, in contrast to this model, John Dewey introduced an innovative trend in the field of pedagogy, proposing that school life should enhance and structure life outside school. His approach focused on autonomous problem solving by students, emphasising self-regulation and collaborative learning. Thus, school should be conceived as a laboratory where students are prepared to resolve conflicts (Feinberg & Torres, 2014).

The adaptation of school with real life produces innovations where the ideas of change and educational reform are deeply connected (García & Martija, 2006). What do we mean by innovation? Innovation refers to an idea that is perceived as new by someone and leads to the acceptance of this novelty by society or a collective. In planning and preparing for the future (Shehu & Jere, 2015), in the field of education, motivations arise from politics, organisations and educational institutions to work for societal change (Cain et al., 2024) or for crisis needs, such as that suffered by the COVID-19 pandemic.

Due to the social, economic and cultural changes and technological advances of the 21st century (Castro et al., 2023; Llivipuma, 2023), active methodologies have emerged in education. Antagonistic to traditional methods, active methodologies reject the memoristic process and pursue creativity, reasoning, reflection and critical thinking (Peralta & Guamán, 2020). In this sense, active methodologies directly connect the needs derived from today's society and the key competences established by the European Union, including digital competence, STEM (Science, Technology, Engineering and Mathematics) or entrepreneurship, among others (Official European Union Journal, 2018). The focus is on competences, students need to be active and participatory agents with greater practical training in problem solving, in the development of critical capacity and group work skills to face real situations (Muntaner et al., 2020).

Although prospective teachers' perceptions vary on how to use technology for learning, for the most part they share an obligation to use technology in useful and effective ways (Delaney et al., 2014). Projects and learning situations supported with technological tools have important implications for future classroom learning, which is

no longer limited or focused on textbooks (Harris, 2017). In relation to technological advances, the progressive irruption and integration of digitalisation and its applications (Sanz-Benito et al., 2024) in everyday life by all age ranges, children and adults, requires schools to integrate these digital tools, bringing about innovation and methodological changes in schools (Chiu et al., 2024). These tools and applications allow learning by researching, creating or presenting meaningful projects, changing the role of both the teacher and the student, the latter with a more active participation.

Traditional methodology and spaces versus Future Classroom Lab

In response to the need for changes in education and with the aim of adapting education to social changes and advances, the European educational project called Future Classroom Lab emerged, promoted by the European Schoolnet, considered one of the most didactically relevant proposals in the field of education (González-Pérez et al., 2022). The FCL is based on the research results of the iTEC project, funded by the European Commission (Blahová et al., 2013) to foster a shift from the classroom to creative and engaging spaces (Kanematsu & Barry, 2016) that integrate Dewey's conception, where classrooms are considered multimedia laboratories and learning spaces based on active methodologies (Jin & Peng, 2022; Pedro et al., 2017). Adapting the spaces of educational centres based on FCL entails a methodological change in the educational projects of schools that require innovation including practical, communicative and technological skills, offering a new pedagogy where interaction is the main core to establish a dynamic, creative and free classroom environment (Zhang & Chen, 2011).

The objective of the FCL project was to experiment with new teaching-learning models and to improve the contextualised integration of ICT in the classroom in order to transform and improve their use in education (Tena & Carrera, 2020). Belgium is the forerunner of the prototype with its Brussels-based FCL, along with the two Iberian countries, Spain and Portugal, which are examples of how the model can be adapted to the specific needs of each nation (Caballero-García et al., 2022). These innovative and flexible zones are expanding in different parts of the world (Peña, 2023), not only at the European level.

Their reconfigurable layout, flexible and multifunctional furniture are intended to be the model for new classroom dynamics through active learning methodologies and the innovative use of digital technologies (Baeta & Pedro, 2017). Currently, the spaces proposed by the FCL are interact, investigate, develop, exchange, create and present (Figure 1).

These FCL learning zones in schools require a change in the role of teachers and adaptation to new contexts (Bautista & Borges, 2013) and, therefore, a methodological change. The technological tools that can be used in these spaces contribute to the

development of computational thinking (programming, robotics or AI) and digital competences of students (Dúo-Terrón, 2023). Of particular relevance is the promotion of creativity, associated with the 'A' of art together with the use of technology, promoting STEAM education (Marín-Marín et al., 2021).

FIGURE 1



Therefore, in FCL there is no place for traditional methods because students are the protagonists of their learning through practical problem-solving skills and promoting digital innovations (Chiriac, 2019). Furthermore, it has a multidimensional and inclusive approach where all learners, including those with disabilities, are accommodated (Hyun et al., 2022). FCL zones and task-based work support the application of Universal Design for Learning principles in teaching interventions (Hilario et al., 2022).

This way of teaching focused on know-how also implies a change in the processes of competency assessment by educational agents in order to diagnose problems in students' tasks and provide them with quality feedback on how to improve their learning (Fok & Chan, 2013). The use of digital tools and devices allows for teacher-guided learning situations (Hickman, 2016). Students can check the progress of their assignments and assess their own learning, because they can think critically, seek alternative views and perspectives on their assignments (Ntuli & Kyei-Blankson, 2016).

Therefore, FCL spaces are not just for exploring with technology, but have the challenge of rethinking and redesigning educational practice that encourages interaction, experimentation, exchange of ideas and research (González-Pérez et al., 2022).

Justification and objectives

The changes that schools and their spaces have been undergoing over the last decade due to the irruption of digital devices, although they can be beneficial, must be subject

to a pedagogical analysis prior to their introduction, which allows us to decide whether they really serve an educational purpose (Martín-Lucas & Sánchez-Rojo, 2023). The FCL project has gained popularity at the European level among education administrations (Pedro et al., 2017) and is spreading worldwide. Although it was created to reorganise conventional classrooms and other learning spaces in order to support methodological changes in teaching and learning, scientific evidence on the adaptation of FCL spaces in schools and their pedagogical impact with technologies and 21st century competence skills is scarce (Gómez-García et al., 2022; Sardinha et al., 2017a).

For this reason and given that there has been no scientific analysis of the FCL since its creation in 2012, this study is considered essential to lay the foundations in this field that offer solid perspectives in the field of education and open up future lines of research. To this end, we have chosen to carry out a systematic review of the scientific literature of studies based on the FCL and to show what the field of research indicates about the impact of this phenomenon. Therefore, the main objective of this research is to find out about the scientific production of the FCL in the Web of Science (WoS) and Scopus databases. This main objective derives from the following specific objectives:

- To know the scientific production, types of manuscripts, countries and authors of major relevance on FCL.
- To find out the most relevant terms, objectives, types of manuscripts and methods of FCL study.
- To explore the main conclusions of the scientific literature based on FCL.

METHOD

To achieve the stated objectives, this research is based on a systematic review of the scientific literature following the guidelines developed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). In order to achieve high scientific rigor in the study, the Web of Science (WoS) and Scopus databases have been used because they gather articles of impact and relevance, in addition, they are considered the main databases worldwide for scientific dissemination (Pérez-Escoda, 2017). In turn, their publications have been peer-reviewed and evaluated (Caballero-García et al., 2022). Another reason for selecting these databases is because impact publications related to innovation in education and technology are integrated (Ramírez-Montoya & Lugo-Ocando, 2020). The variables selected to follow this study have been; scientific production, analysis of authors, countries, emerging terms, objectives, types of manuscripts, study methods, conclusions and findings on FCL.

Procedure

The research was carried out in the second quarter of the year 2024 with the aim of covering all the scientific literature in previous years (López-Belmonte et al., 2023). First of all, the terms to be included in the search field of the different databases were selected; in addition, in WoS the search was carried out from the main collection of WoS. In both databases we proceeded to search for all the articles that included all the fields and with a date between January 1, 2010 and December 31, 2023. The year 2024 was discarded because it was not completed and because no document was found in that year up to the date of the research.

Next, the term “Future classroom” is included in the search due to the fact that there are countries such as Spain that eliminate the word laboratory (Lab, in English) and do not use the full term “Future Classroom Lab” as it is originally called from the European Schoolnet, together with the selection of all topics, that is, titles, abstracts and indexing. Consequently, a holistic perspective in the educational field is achieved.

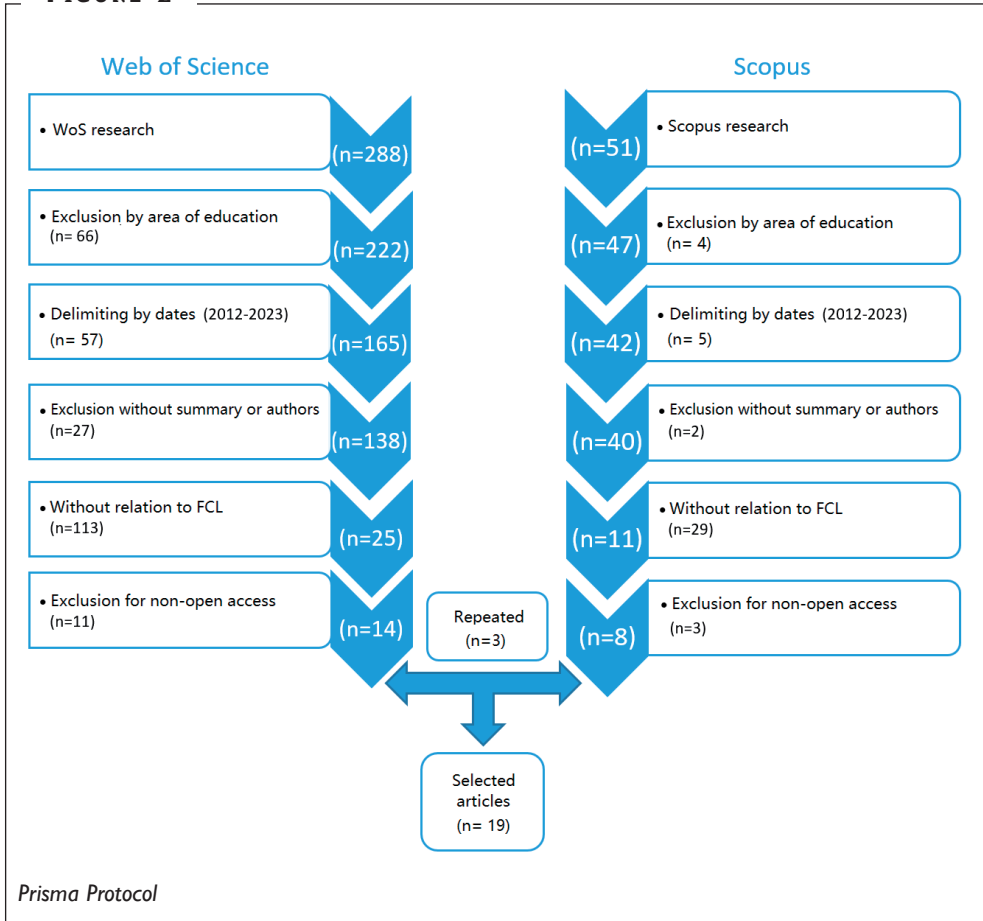
To filter and select in detail the manuscripts related to the FCL in education, the standardized protocol of the PRISMA statement (Sánchez-Serrano et al., 2020) was taken into consideration from the two databases, as shown in Figure 2. 288 results were obtained in WoS for all dates, and then refined by areas of education ($n=222$). Subsequently, it is delimited from the year 2012 when the project starts until the full year 2023 ($n=165$). These documents are downloaded for analysis, in which the author excludes documents for lacking an abstract ($n=1$) and having no authors ($n=26$). During the reading of the abstracts, it is found that $n=103$ are not related to the FCL for different reasons. Finally, we proceeded to search the selected papers and $n=11$ were closed or paywalled articles. A total of 14 articles were included from WoS.

In the Scopus database, the same procedure was carried out, finding $n=57$ documents referring to the FCL. Delimiting by areas related to education, $n=47$ are included. Narrowing the year from 2012, $n=42$ documents are obtained, which are downloaded and analyzed. Of these, those without authors ($n=1$), abstracts ($n=1$), unrelated to the FCL ($n=29$) and not having open access ($n=3$) are excluded, including ($n=8$) articles from Scopus. Of the total number of articles selected in WoS ($n=13$) and Scopus ($n=8$), $n=3$ were repeated and the final review of $n=19$ documents was carried out.

For the extraction of the term network map of the 19 articles, the text files were downloaded and inserted into the statistical program Vosviewer. Subsequently, the option to create a co-occurrence map of terms from the database was chosen. Then, reading the data from the Vosviewer file and a binary counting method were selected. A “thesaurus” document was inserted because similar concepts such as “FCL”, “Future Classroom Lab” and “Future Classroom” were found, choosing to group all these terms as one with the name “Future Classroom”. Subsequently, those terms with a minimum number of co-occurrences ($x>5$) were selected, detecting the program $n=52$ terms

that reached the established threshold. Based on this score, 67% of terms with the highest relevance were chosen, that is a total of n=35 terms which are detailed in the following results section.

FIGURE 2



RESULTS

For the presentation of the different results, the selected articles are shown in Table I ordered by decreasing period in order to facilitate and identify the articles in the various subsections.

TABLE 1*Scientific production and year*

Tittles	Year
The Spanish experience of the future classrooms as a possibility of smart learning environments	2023
Future Classrooms in Spain: An analysis from teacher's perspective	2023
Educating for professional digital competence? Exploring teacher education in a new learning space	2023
Technology and teaching space: A pedagogical approach to the Classroom of the Future	2023
The Future Classroom Lab as a space that supports methodological change	2022
Impact of the pandemic on STEAM disciplines in the sixth grade of primary school	2022
Student assistants in Future Classroom Labs moving between figured worlds and becoming a resource for developing professional digital competence in the teacher education	2022
Trends in the concept of educational spaces	2022
The Classroom of the Future: a project for the pedagogical redefinition of educational centers	2022
Model of Future Classrooms in the region of Dão Lafões	2021
The Future Classroom Lab as a framework for developing competence-based learning and project work.	2020
Future Classroom Labs in Norwegian Pre-service Teacher Education.	2018
Bridging approaches: Classroom Physical Space as a learning ecosystem	2017
The Classroom Physical Space as a Learning Ecosystem - Bridging Approaches: Results from a Web Survey	2017
Technological Resources and Motivation for Learning	2017
Educational Occupations and Classroom Technology: Lessons from Democracy and Education	2016
Construction of Future Classroom in Primary School	2013
Smart Classrooms: Innovation in formal learning spaces to transform learning experiences	2013
iTEC - Innovative Technologies for an Engaging Classroom	2012

Results on scientific production, countries and authors of greatest relevance

In relation to the first objective of the research, it is possible to observe the time periods corresponding to the scientific production since 2012. In this year the iTEC Project (Jørund, 2012) develops the first research managed by the EUN. The year 2022 was the most productive with 5 articles, followed by the year 2023 with 4 manuscripts. The years 2014, 2015 and 2019 lack FCL research.

In relation to the authors related to research on FCL, a total of 37 authors appear, of which 6 authors have two contributions (Almeida, Ana Margarida; Arstorp, Ann-

Thérèse; García-Tudela, Pedro-Antonio; Prendes-Espinosa, Paz; Sardinha, Lara and Solano-Fernández, Isabel María) and the rest have 1 contribution in this field. Spanish researchers represent 58% of the studies, followed by Portugal (19%), Norway (9%), Belgium and China (5%) and, finally, Costa Rica and the USA (2%).

Results on most relevant terms, objectives, types of manuscripts and study methods

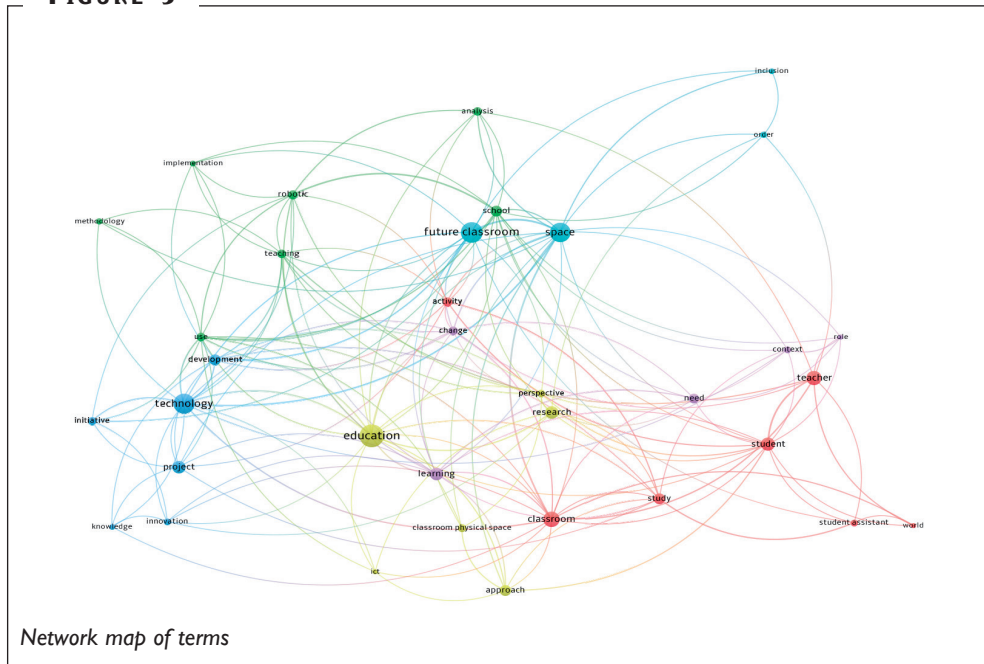
Table 2 shows the most relevant terms of the 19 research manuscripts, highlighting the five terms with the highest co-occurrence which are “education”, ‘Classroom of the Future”, “Technology”, “Spaces” and “Classroom”.

TABLE 2

Relevant terms and level of co-occurrence

Terms	Co-occurrence	Terms	Co-occurrence
Education	48	Teaching	11
Future Classroom	41	Analysis	11
Technology	40	Change	11
Spaces	39	Physical classroom space	10
Classroom	27	Initiative	10
Teacher	23	Perspective	9
Students	21	Student assistant	8
Project	20	Innovation	8
Research	20	Context	8
Learning	19	Methodology	7
Approach	16	Order	7
Study	15	Inclusion	6
Development	15	Knowledge	6
School	15	Implementation	6
Needs	13	World,	5
Robotics	12	Role	5
Activity	12	ICT	5
Use	11	-----	-----

Derived from the terms in the previous figure and their level of co-occurrence, Figure 4 shows in a network map the connections that exist between all the terms.

FIGURE 3

In relation to the objectives of the different FCL articles, the first iTEC project aimed to bring together researchers, technology providers, policy makers and innovative teachers to design and build teaching-learning scenarios for FCL (Jørund, 2012). Similarly, the article by Wu & Liu (2013) aims to describe general principles on designing FCL to enhance present, future and role learning needs. In addition, another objective related to studying the design and use of these spaces appear in three contributions with interviews to professionals (Arstorp, 2018, 2022; Tømte & Lazareva, 2023), among them, a manuscript aims to know the intentionality of the creation of FCL spaces and to highlight the results of the FCL project from the countries of Portugal and Spain (Tena & Carrera, 2020).

In relation to educational practices, research mainly focuses on studying the perceptions and degree of satisfaction of teacher trainers, teachers and students during the teaching-learning process in these spaces (Caballero-García et al., 2022; Ferreira, 2021; Tømte & Lazareva, 2023; González-Pérez et al., 2022). Besides, compare FCL spaces with traditional classrooms (García-Tudela et al., 2023a; Gómez-García et al., 2022, Hickman, 2016). In addition, to analyze the technologies used in FCL in Spain (García-Tudela et al., 2023b) and to understand how they were created and the current use of FCL (Sardinha et al., 2018). Relating the motivation produced by ICT (Sardinha et al., 2017a). One article, presents as an objective to evaluate STEAM disciplines in FCL in pandemic times (Dúo-Terrón et al., 2022).

The 19 types of manuscripts are divided into 11 research articles, one of them presented as a book chapter. In addition, 4 review publications (3 in conferences as book chapters and 1 in research article), 2 doctoral theses, 1 review article and 1 interview.

In relation to the study methods, the quantitative method stands out (Ferreira, 2021; González-Pérez, 2022; Sardinha et al., 2017a, 2017b) followed by the qualitative method (Arstorp, 2022; Tena & Carrera, 2020; Tømte & Lazareva, 2023). There are also two exploratory articles (García-Tudela et al., 2023a, 2023b), a quasi-experimental method with control and experimental groups performing pre-test and post-test (Dúo-Terrón et al., 2022) and a review of scientific literature to discover what concepts are considered relevant about educational spaces creating trends (Caballero-García et al., 2022). Finally, the iTEC method stands out with more than 1,000 school pilot programs, with emphasis on science and mathematics in secondary schools with a duration of 4 years (Jørund, 2012). In 4 of the articles, the method does not appear because they are considered review articles (Bautista & Borges, 2013; Hickman, 2016; Martín-Lucas & Sánchez-Rojo, 2023; Wu & Liu, 2013).

DISCUSSION

The irruption of technologies and devices connected to the Internet have managed to occupy traditional spaces and methodologies. Moreover, this presence in the classroom requires teacher training in digital competence and in methodologies that support cooperative work, interaction, experimentation, exchange of ideas or research, which means that spaces must be flexible and dynamic, giving rise to FCL, as González-Pérez et al. (2022) point out. For this reason, we proceed to discuss and contrast the pedagogical purpose of FCL from the perspective of the scientific evidence so far.

In relation to the first objective “To know the scientific production, types of manuscripts, countries and authors of greatest relevance on FCL”

The FCL is a project that since 2012 has been able to replicate more than 240 FCLs in 29 countries. It is a project that since 2012 has been able to replicate more than 240 FCL by 29 countries, train more than 3,000 teachers or has received more than 10,000 visitors to its facilities in Brussels (Belgium) according to Dalla-Vechia (2024). However, the scientific production of research on FCL during the 12 years found in the results of this study is irregular and scarce, in line with the studies of Gómez-García et al. (2022) and Sardinha et al. (2017a). Nineteen research studies were found, of which more than 50% were conducted in the last three years. The year 2022 has more scientific contributions with a total of 5, but there are years where there has been no research in this European project, namely 2013, 2014 and 2019.

In relation to the countries and authors with more productions, Spain contributes

more productions and authors researching in this field. In this sense, as the study by Tena and Carrera (2020) indicates, it is the Ministry of Education itself that should lay the foundations for having an FCL, as in the case of Spain, which has a network of ambassadors throughout the country. This example should be identified as a clear commitment to methodological change that performs consultancy and teacher training functions at all non-university educational stages. In addition, there are more than a hundred teacher training centres and educational centres with the “FCL seal” at the end of 2023 (Spanish Government) and recognised by the Spanish Ministry of Education. Therefore, this large-scale project may be the reason that generates interest in Spain with almost 60% of researchers.

Highlights that countries that are part of the FCL project do not have scientific evidence in the databases analysed such as Turkey, Slovakia or Denmark. In Turkey, the ‘Zile Fen Lisesi’ project promotes blended learning in secondary schools and the development of 21st century skills. The FCL Beest project in Slovakia, with an FCL integrated into a primary school building and used for extracurricular activities. Finally, the FCL DK project in Copenhagen, Denmark, with a laboratory that is part of the Carlsberg Campus and used by 10,000 students and a wide range of local primary and secondary schools.

In relation to the second objective ‘To find out the most relevant terms, objectives, types of manuscripts and methods of studying FCL’

In relation to the second objective of this research, the most prominent term is ‘technology’ in the analysed studies, excluding ‘education’ and ‘Future Classroom’ which are the focus of the topic. Therefore, the results of this study support that the advent of emerging ICT-based pedagogical approaches produces an increase in studies on the physical environment of the classroom, as space and layout are no longer adequate as pointed out by Gómez-García et al. (2022) and Sardinha et al. (2017a). If we focus on the teaching-learning process, the term ‘teacher’ has more presence than the term ‘student’, this may be due, as Tømte and Lazareva (2023) point out, to the fact that the digital transformation primarily affects the role of the teacher and their training that are the object of study, which may cause problems conditioned by the way of understanding and interpreting the way of educating and their methodology according to age, motivation or knowledge. In this sense, Tena et al. (2020) point out that the prominence of digital resources should not be understood as a commitment to focus more on the work of digital competence.

The study by Baeta and Pedro (2017) considers the FCL a model of new classroom dynamics through the articulation between active learning methodologies together with the innovative use of technologies according to Martínez-Ezquerro (2020) with adequate training on attention to diversity in the FCL and with a multidimensional

and inclusive approach for all students as supported by the study Jin and Pen (2022). However, in the results of this study and attending to the terms analyzed, the term “inclusion” has a low level of co-occurrence, contrary to the study of Hyun et al. (2022) that considers them multidimensional and inclusive spaces for all students, including those with disabilities. Similarly, García-Tudela et al. (2023a), among their conclusions, state that attention to diversity, despite the existence of initiatives to personalize the learning experience in FCL, are not considered assistive technologies in their study.

In view of the focus of the types of manuscripts found in the results of this study, there are 11 research articles in 12 years on FCL with teachers or students in line with the study by Sardinha et al. (2017a). Therefore, there is no solid scientific evidence to identify and catalog FCL as learning-enabling spaces. On the other hand, the study by Pedro et al. (2017) confirms that active methodologies have recently gained importance in educational research, although in this study, the term active methodologies linked to the FCL project does not appear among those highlighted for the development of 21st century competences. Furthermore, the study by García-Tudela et al. (2023b) supports this theory by including that teachers consider the FCL to be environments where educational activity is not developed in its entirety, but rather isolated initiatives and practices over time.

In relation to the third objective “To explore the main conclusions of the scientific literature based on the FCL”

The third objective of this study highlights the research of Wu and Liu (2013), considering that the traditional classroom has disadvantages such as being inflexible, stereotyped, boring and criticized, which is not beneficial to the development of students’ quality. On the contrary, the FCL design aims to overcome the weakness of the traditional classroom and give a dominant active role of students attending to inclusion. In order to make a methodological change, the configuration of the FCL must respond to real educational demands of the center, which must require the transformation of the role of its teachers and modify the pace of teaching according to the sociodemographic context and not be influenced by administrative, political or social trends as pointed out by the study of Martín-Lucas and Sánchez-Rojo (2023).

Therefore, despite the fact that FCLs and technologies generate motivation among teachers and students as pointed out by the studies of Dúo-Terrón et al. (2022), de Ponte (2017) and Nurmi and Kiuru (2015), it is necessary to clarify that the objective of FCLs is to create a meeting model dedicated to the reconsideration of educational models and the exploration of new perspectives, involving students, teachers and parents. Subsequently, each country and educational center should have the necessary autonomy to develop its own projects, pedagogy and unique methodology, where digital resources should not be interpreted as an exclusive prioritization of digital

competence as stated by González-Pérez et al. (2022) to the detriment of other competencies as argued by FCL promoters in Belgium, Portugal and Spain in the study by Tena and Carrera (2020).

Another question provided by the results of the studies analyzed are the business opportunities that arise due to the irruption of educational innovation linked to the development of technological applications and threaten the educational system in line with the study by Solé-Blanch (2020). In addition, Gómez-Pérez et al. (2022) points out that the educational system receives pressures from educational policies to adapt it to the needs of the economic world. The conclusions of the studies analyzed also include criticisms of the FCL project, such as the study by Martín-Lucas and Sánchez-Rojo (2023), which questions the extent to which the configuration of its spaces does not respond to educational demands, but to social ones. It also indicates that the diaphanous space replaced by glass partitions, opens it to the outside, not being an autonomous environment, not only because it allows to see what is happening outside, but also because it is designed so that nothing can be hung on it. Another criticism, is that the modification of these spaces needs a lot of time and energy to plan them, where the greatest effort and initiative falls on the management teams as indicated by the studies of García-Tudela et al. (2023b) and Arstorp (2018).

CONCLUSION

In the fourth industrial revolution, the use of digital technologies and devices such as the use of interactive screens, educational applications, robotics or artificial intelligence are transforming our reality causing educational innovations different from traditional methods. Faced with these significant challenges, educational institutions and centers are adapting traditional spaces into flexible spaces in order to meet the emerging educational demands of a constantly changing and increasingly digitized society. However, scientific evidence is needed to provide data on how to carry out these transformations.

After the systematic review conducted in this study on the FCL project coming from the European Schoolnet in Brussels in 2012 until 2023, the main conclusions that can be drawn are that the maker spaces based on this project do not have a sufficient scientific basis with 19 manuscripts in 12 years. The country and authors with the most research in the scientific literature belong to Spain. The most used terms in the scientific literature are “education”, “classroom of the future”, “technology”, “spaces”, “classroom”, “teacher”, “student”. Among the manuscripts there are 11 research articles, 4 review publications, 2 doctoral theses, 1 review article on educational spaces and 1 interview with promoters of the FCL project in Europe.

Among the objectives and conclusions of the studies analyzed, the motivation gen-

erated by CFLs and the use of ICTs stands out; therefore, a reform of traditional spaces and methods is considered necessary. However, some studies consider that the FCL should be adapted to the sociodemographic contexts and methodological demands of the educational centers themselves. There are difficulties such as budget, lack of space in the centers and the need for training in active methodologies with technologies that also address inclusion and diversity.

The limitations of this study are that the focus of the research has been centered solely on the FCL Project, but there are countries and communities with educational centers that do have creative spaces similar to the FCL and that employ active methodologies and are immersed in similar projects, but with other names.

For future lines of research and as a result of the results found in this research, it is necessary to obtain scientific evidence on studies that have an impact on learning outcomes based on the development of competencies in FCL spaces, focusing on know-how, attention to diversity and an evaluation by levels of achievement in competencies. Also, to focus studies on real learning situations that transmit how to transfer a curricular project to FCL spaces, interact, explore, investigate, research, develop, create and present. Finally, if an FCL exists in an educational center, study how it has been implemented, how it is financed and how teachers organize the use of these spaces with the entire educational community.

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