Webology (ISSN: 1735-188X)
Volume 19, Number 2, 2022

Digital Skills And STEAM In Education: Systematic Mapping Between 2017 And 2021

Alexandra Abuchar Porras[1], Sandra Yanet Velazco Flórez[2], Laura de Miguel Álvarez[3], Fredys A. Simanca H.[4]

Systems Engineer from the Universidad Antonio Nariño, specialist in University Teaching, specialist in Multimedia for teaching, Master in Computer Science Applied to Education from the Universidad Cooperativa de Colombia, member of the research group LIDER, teacher at the Universidad Distrital Francisco José de Caldas, Bogotá (Colombia). PhD student in Knowledge Society and Action in the fields of Education, Communication, Rights and New Technologies at the Universidad Internacional de la Rioja(UNIR) Spain. https://orcid.org/0000-0001-8869-7129. Institutional

[2]Civil Engineer from the Universidad Francisco de Paula Santander (Cúcuta, Colombia), specialist in Geographic Information Systems from the Universidad Distrital Francisco José de Caldas and PhD in Computer Engineering, Geographic Information Systems program from the Universidad Pontificia de Salamanca (Spain). As a professor at Universidad de la Salle, she has been participating in research processes in the areas of GI Science (Geospatial Information Sciences) and Geomatics. Her academic areas of interest are related to Geomatics, especially GIS (Geographic Information Systems) and its applications, Territorial Artificial Intelligence, GIS Project Management, Spatial Data Infrastructure and Smart Cities..https://orcid.org/0000-0003-3764-0557, Institutional

[3]Ph.D in Fine Arts from the UCM. Professor Accredited by the ANECA as Professor of University. Degree in Fine Arts from the UCM with the specialty of Image Arts. Research teaching staff at ESIT (School of Engineering and Technology) of the International University of La Rioja - UNIR. With more than 15 years in the university field, she has been specializing in teaching and authoring content in areas of Graphic-Artistic Expression and Design (graphic,

[1]Systems Engineer from the Universidad Antonio Nariño, specialist in University Teaching, specialist in Multimedia for teaching, Master in Computer Science Applied to Education from the Universidad Cooperativa de Colombia, member of the research group LIDER, teacher at the Universidad Distrital Francisco José de Caldas, Bogotá (Colombia). PhD student in Knowledge Society and Action in the fields of Education, Communication, Rights and New Technologies at theUniversidad Internacional de la Rioja(UNIR) Spain. https://orcid.org/0000-0001-8869-7129. Institutional mail:aabucharp@udistrital.edu.co

[2] Civil Engineer from the Universidad Francisco de Paula Santander (Cúcuta, Colombia), specialist in Geographic Information Systems from the Universidad Distrital Francisco José de Caldas and PhD in Computer Engineering, Geographic Information Systems program from the Universidad Pontificia de Salamanca (Spain). As a professor at Universidad de la Salle, she has been participating in research processes in the areas of GIScience (Geospatial Information Sciences) and Geomatics. Her academic areas of interest are related to Geomatics, especially GIS (Geographic Information Systems) and its applications, Territorial Artificial Intelligence, GIS Project Management, Spatial Data Infrastructure and Smart Cities..https://orcid.org/0000-0003-3764-0557, Institutional Mail:svelazco@unisalle.edu.co

[3]PhD in Fine Arts from the UCM. Professor Accredited by the ANECA as Professor of University. Degree in Fine Arts from the UCM with the specialty of Image Arts. Research teaching staff at ESIT (School of Engineering and Technology) of the International University of La Rioja - UNIR. With more than 15 years in the university field, she has been specializing in teaching and authoring content in areas of Graphic-Artistic Expression and Design (graphic, industrial, fashion, etc.) teaching subjects such as: creativity, drawing, analysis of form, projects, etc.. Director of the Master in Digital Graphic Design at UNIR and of the DiSEA Research Group - Design, Society, Education, Art. https://orcid.org/0000-0002-2735-552.Institutional mail: laura.demiguel@unir.net

[4]Doctor in Knowledge Society, International University of La Rioja (Spain), Master in Computer Science Applied to Education, Specialist in Multimedia for Teaching, Specialist in Telecommunications Networks and Systems Engineer from the Cooperative University of Colombia, Bogota-Colombia. ORCID: https://orcid.org/0000-0002-3548-0775. Institutional mail: Fredys.simanca@campusucc.edu.co

industrial, fashion, etc.) teaching subjects such as: creativity, drawing, analysis of form, projects, etc.. Director of the Master in Digital Graphic Design at UNIR and of the Di SEA Research Group - Design, Society, Education, Art. https://orcid.org/0000-0002-2735-552.Institutional

[4]Doctor in Knowledge Society, International University of La Rioja (Spain), Master in Computer Science Applied to Education, Specialist in Multimedia for Teaching, Specialist in Telecommunications Networks and Systems Engineer from the Cooperative University of Colombia, Bogota-Colombia. ORCID: https://orcid.org/0000-0002-3548-0775. Institutional

Abstract

This article presents the results obtained through the technique of quantitative content analysis applied to the topic of digital competencies and STEAM in education, in the period between 2017 and 2021, in order to determine the research conducted on this topic. The method of systematic mapping of the literature on the STEAM approach in education was developed, for which the Web of Science and Scopus databases were used, finding 214 articles in a general level, of which 61 have open access.

The main objective is to identify the characteristics of the documents, to examine which of them have the greatest impact; which are the lines of research; to identify the main journals and their classification; to establish in which languages STEAM is published; to recognize which are the countries where the research comes from, to determine which types of documents. Concluding with a final product called mapping of the production on the subject, which allows and enables researchers and interested readers to delve deeper into the subject, through a careful selection of the main academic articles of the last five years.

This article is the result of the first stage of a research that is under development in the PhD program in the Knowledge Society and Action in the fields of Education, Communication, Rights and New Technologies of the UNIR University of Spain. The authors of the article are conducting the research, which main topic is the development of a model for the implementation of digital skills through the development of STEAM projectswith displaced women victims of the armed conflict. Case: Quibdó.

Key words: STEAM, Competence, digital, skills.

1. Introduction

The potentiation of skills and competencies in different areas of knowledge are indispensable characteristics in any learning process within the educational system, therefore, it is necessary to know how these learning processes and the development of digital competencies are being addressed and potentiated in students.

Authors such as Barreto (2017), Jiménez, et al., (2017), Mitra and Crawley (2014), Idalia & Gonz (2012) and Belloch (2002), state that the digital society of the 21st century demands the development of specific skills and competencies for performance in digital contexts, therefore, this requires individuals capable of appropriating technologies and these in turn, must be achieved to ensure a dynamic participation in society. In this way, when used, individuals

achieve empowerment of technological resources through collaborative work, becoming indispensable competencies to be participants in society.

In this sense, it is important to create strategies to strengthen education, potentiate and strengthen skills, capabilities and competencies, allowing the individual to have strategies and tools to perform effectively in different environments. Likewise, it is considered fundamental, the training of individuals in the use, appropriation and diversification of digital knowledge, since these allow to increase productivity levels in organizations and thus achieve a higher level in the quality of life of people.

1.1 Digital Competencies

The European Parliament (2005) presents digital competence as "involving the confident and critical use of electronic media for work, leisure and communication. They are related to logical and critical thinking, high-level information management skills and with the efficient development of communication skills" (p. 17). On the other hand, according to the European Parliament and the Council (2006) digital competence is "the critical and confident use of Information Society Technologies for work, leisure and communication. Relying on basic ICT skills: use of computers to recover, evaluate, store, produce, present and exchange information, and to communicate and participate in collaboration networks through the Internet" (, p. 15).

Additionally, Ferrari (2012) in the document on "Digital competence in practice: an analysis of frameworks", indicates that digital competence is the compendium of knowledge and skills that are indispensable in the use and appropriation of the digital environment. Similarly, Esteve-Mon, Gisbert-Cervera and Lázaro-Cantabrana (2016) define digital competence as the inflow of values, beliefs, knowledge, skills and attitudes to conveniently take advantage of technology, enabling the use and appropriation of digital resources and media.

According to these definitions, it can be specified that digital competencies are shown as a key element for life, becoming a fundamental capacity for society, where people need to develop skills and abilities in digital use and appropriation. Esteve and Gisbert (2013) pointed out that digital literacy processes are essential to adequately train in the use of digital tools. In such a way, that it provides not only the ability to access, manage, integrate, evaluate or analyze, but also to enhance communication in different contexts and in different formats. In this line, authors such as Simanca, Abuchar-Porras, & Velazco (2017) express that "virtual learning environments and educational software represent a viable and complementary alternative in the educational process".

1.2 STEAM Approach

Watson & Watson (2013a) state that in 2001, the National Science Foundation presented the result of an investigation in which Science, Technology, Engineering and Mathematics are integrated, known as STEM approach. This new educational perspective, through the process of inquiry and project development, explores different ways of providing solutions to real problems, allowing it to become a fundamental cornerstone in the reform of PK-12 education, name given to the education system that covers prekindergarten, primary and secondary

education in some countries such as the United States, the Philippines, Canada, Australia and Ecuador.

Later investigations, such as those developed by Yakman (2008), Park, Byun, Sim, Han, &Baek (2016), or Segarra, Natalizio, Falkenberg, Pulford, & Holmes (2018), take into consideration, the influence and importance of the artistic expression of the human being in all the dimensions in which he/she develops as a transversal factor to the areas of the STEM approach and propose to include "arts". This is how the research process is recognized and the "A" is included in the acronym STEAM (Science, Technology, Engineering, Arts and Math).

STEAM is an integrative and interdisciplinary approach, showing itself as an academic strategy to achieve learning objectives. According to Van der Linde (2014), STEAM integrates several disciplines and these require the development of skills and competencies that are intertwined in order to provide solutions to real problems. For other authors such as Zollman (2012), Land (2013), López, Lagarón, & Rodríguez (2018) STEAM focuses on comprehensive education and continuous learning. Likewise, Chien, Chu (2017), How, Loong, & Hung (2019), affirm that the STEAM approach favors the development of digital competencies essential for the 21st century, a topic widely addressed by UNESCO (2018) and the Broadband Commission (2019), thus, they establish the importance of this approach to provide greater employability, entrepreneurship and academic training.

On the other hand, the STEAM approach finds a correlation with the teaching-learning processes, in elementary schools and/or colleges with teenagers. Yakman & Lee (2012), Paredes (2018), Wang et al., (2018), Vega Valencia, L. (2018), analyze the STEAM approach in countries such as the United States and South Korea; in the latter case, they present it as the main axis of the Korean educational system, stating that STEAM education contributes and optimizes students' literacy, teaching them to have attitudes, habits and more intellectual skills.

Therefore, it is necessary to establish active methodologies in learning and the development of STEAM projects focused mainly on the teaching-learning processes, as emphasized by Watson & Watson (2013), Fernández (2006), Quiroz and Castillo (2017). As well, these authors consider the need to organize training and awareness days for teachers on project-based learning, since these are considered as the strategy in which the STEAM approach works best. Likewise, special emphasis should be given to how students, through the execution of a project, provide solutions to real-world problems.

It is necessary to continue researching in order to strengthen the links between teaching and learning processes supported by digital competencies with STEAM approach, favoring the educational process with education strategies. This work provides a research process of systematic mapping of information, which will be a reference for the interested community, on digital competencies and STEAM approach in education, presenting the most significant published products in the last five years.

1. Methodology

The methodology carried out is based on a systematic information mapping process in reference to the production of articles and research on digital competencies and the STEAM approach. The

latter topic is relatively new and is still evolving, so just by performing a direct search using the terms "digital competencies" and "STEAM approach" in education, in databases such as Web of Science or Scopus, 214 documents are visualized in the period between 2017 and 2021.

The following specific objectives are proposed for the systematic mapping:

1. To establish the production trajectories of the topic in a period from 2017 to 2021.
2. To recognize the country and the language where the research on the subject(s) is (are) carried out.
3. Characterize the production of articles on digital competencies and STEAM approach in education in relation to accessibility and type of production.
4. To identify the works with the greatest impact in the last five years.
5. To recognize the journals with the highest production on the research topics.

As the purpose of this process is to provide a comprehensive analysis of systematic mapping on digital competencies and STEAM approach in education, through a process of inquiry that allows to know the most representative published products in the last five years (2017 -2021). Four methodological phases are developed to address the topic (see Figure 1).

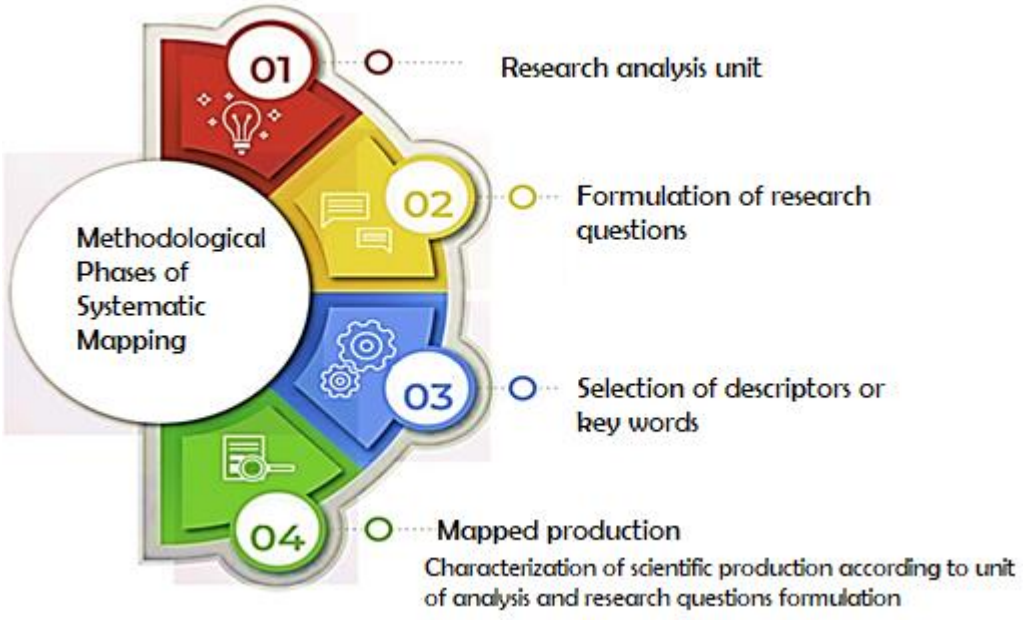

Figure 1. Methodological phases of systematic mapping. Source: own elaboration 2021

1) First phase - Unit of analysis

Relying on Valles (1999, p118), who considers that "the unit of analysis can be a document", in this first phase, the unit of analysis will be reflected with the published articles inherent to the established thematic, "digital competences and the STEAM approach in education between the period 2017 to 2021".

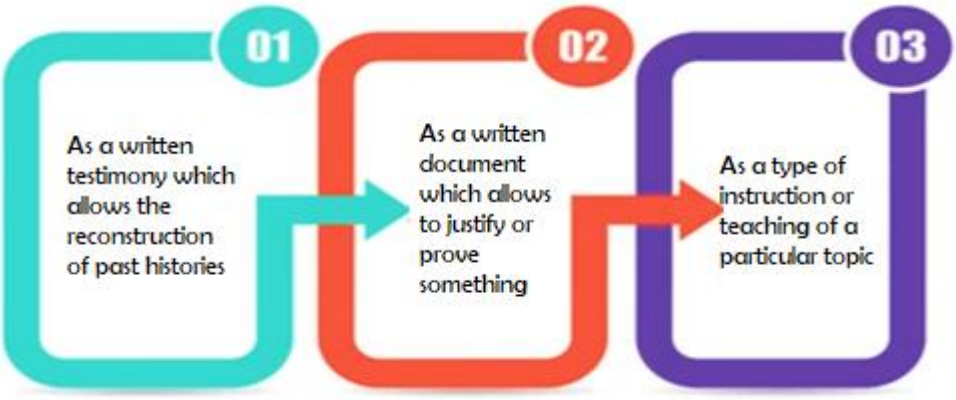

Figure 2. Unit of analysis, the document. Source: own elaboration based on Valles (1999, P118).

2) Formulation of research questions

In this second phase, the problem was established through the formulation of research questions, which provide guidance in the following phases. These research questions are detailed in Table 1.

Table 1. Research Questions

Question Code	Body of the question
QPR1	What is the production of articles between the years 2017 to 2021 on the topic of digital competencies and STEAM in education?
QPR2	In what areas or fields of research is the STEAM approach production in education?
QPR3	How do you typify the production on the topic of digital competencies and STEAM in education?
QPR4	In which languages and in which countries is research on the topic of digital skills and STEAM in education being conducted?
QPR5	Which are the journals that have the most publications about this research topic?

Source: Own elaboration

3) Selection of descriptors or key words.

Identification and characterization of scientific production: The search for scientific production was carried out in the Scopus and Web of Science databases, obtaining 214 articles in total. The search criteria were given by subject, abstract and keywords of the documents published in the indicated period (2017 - 2021). The descriptors used according to the search string were:

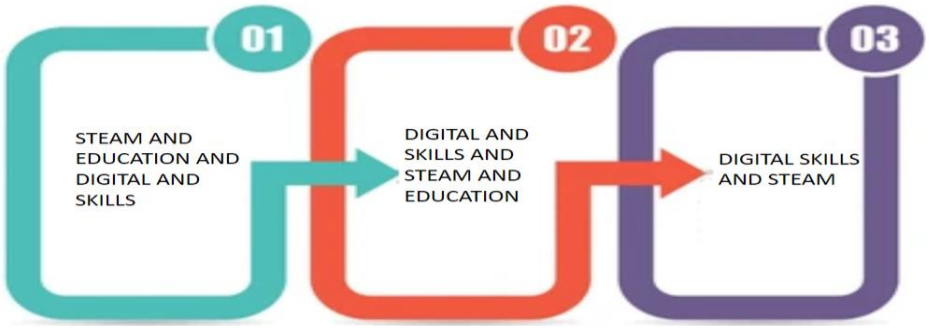

Figure 2. Keywords or descriptors. Source: Own elaboration 2021

The following strategy was implemented for the systematic mapping search:

The scientific production on digital competencies and STEAM approach in education was investigated. The search criteria were assigned in the databases with the fields of title, abstract and keywords. The results were exported to a Microsoft Excel© file.

1) 2. An analysis was made with the keywords and abstracts of each product. Three moments were generated here:
2) a) Reading of the abstracts to corroborate that the articles were related to the topics.
3) b) Identification of the concepts that reflected the research approach and thus understand the nature of the study.
4) Identification of the key words, which provide significant information on the content of the research.

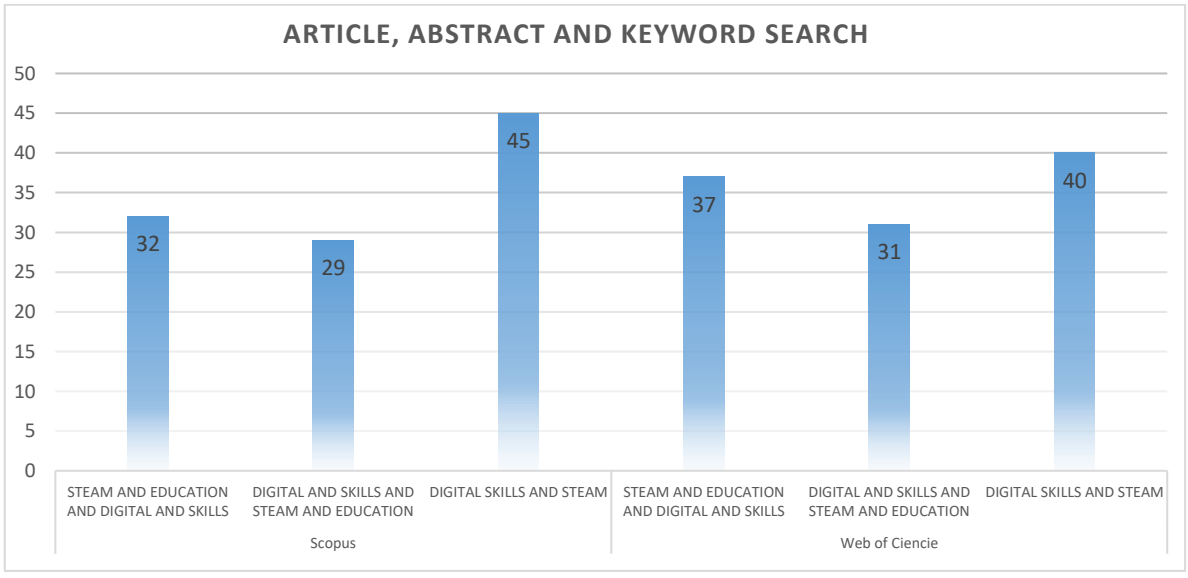

Figure 3. Search for article, abstract and keywords. Source. Own elaboration 2021

4) Mapped Production: Sample Selection

The selection of the sample is given in a period of 5 years (2017 to 2021), establishing a trend of scientific production with temporality, type of access, country, language and type of outreach. For the characterization of the publications, the research questions will be taken into account.

QPR1	**What is the production of articles between the years 2017 to 2021 on the topic of digital competencies and STEAM in education?**

In accordance with the search carried out in the Scopus and Web of Science databases, 214 articles were found on the topics mentioned.

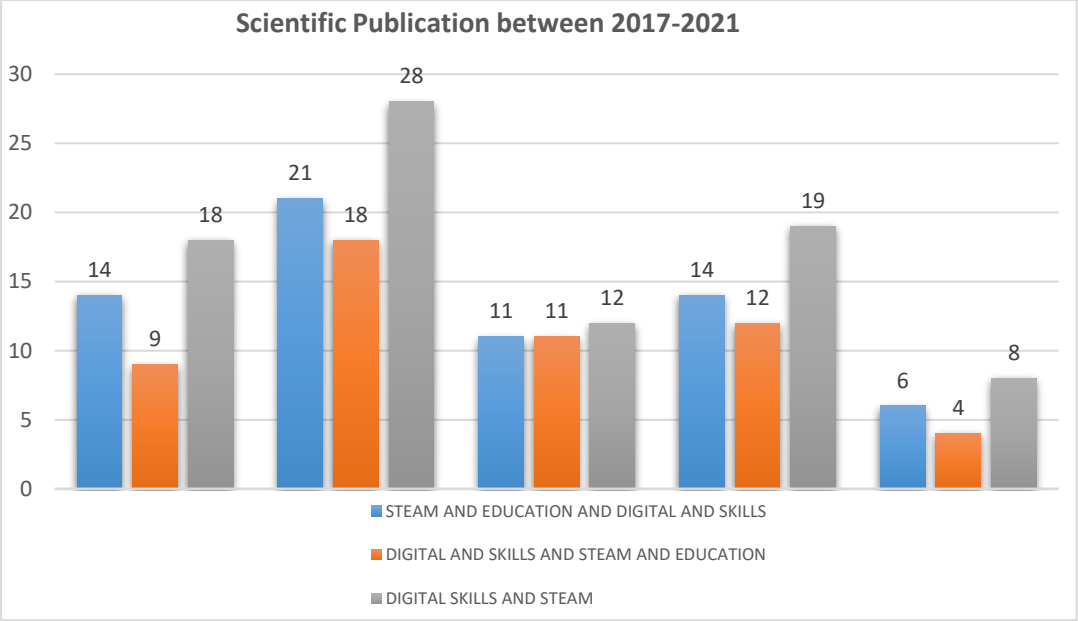

Figure 4. Scientific publication between 2017-2021. Source. Own elaboration 2021

Taking into account that this research was focused on open access documents, they were filtered, obtaining 61 products, which represents approximately 29% of the total scientific production available in the search (see Table 2).

Table 2. Breakdown of research descriptors

Data Base	Key Words	Number of Articles	Open Access Articles
Scopus	STEAM AND EDUCATION AND DIGITAL AND SKILLS	32	9
	DIGITAL AND SKILLS AND STEAM AND ED UCATION	29	9
	DIGITAL SKILLS AND STEAM	45	13
Web of Science	STEAM AND EDUCATION AND DIGITAL AND SKILLS	37	10
	DIGITAL AND SKILLS AND STEAM AND ED UCATION	31	9

	DIGITAL SKILLS AND STEAM	40	11
	Total	**214**	**61**

Source: Own elaboration

The analysis and review by descriptors and titles in the databases made it possible to establish the exclusion filter of units of analysis, which led to purify the documents, thus finding 32 duplicate units of analysis in the database. Achieving a mapping of 29 articles published in the last five years on digital competencies and STEAM approach in education with open access, this process provides an answer to the question QPR1: What production of articles exists between 2017 and 2021 on the topic of digital competencies and STEAM in education?.See Table 5, Mapping production 2017.2021 on digital competencies and STEAM approach in education.

QPR2	**In which areas or fields of research is the production STEAM approach in education?**

The identification of the areas of research on the proposed topic is carried out in the aforementioned databases using the results obtained from the descriptors to which the filter of the most active research areas is applied, thus obtaining 6 areas or fields of research that have production on digital competencies and STEAM in education, shown in Table 3.

Table 3. Categories according to Web of Science and Scopus

Categories according toWeb of science andScopus
1. Educational Research
2. Scientific Disciplines of educations
3. Social Sciences
4. Engineering and computer science
5. Mathematics
6. Arts and humanities

Source: Own elaboration based on data compacted from Scopus and Web of Science.

This process provides an answer to the QPR2 question, in what areas or fields of research is the STEAM approach to education being produced?

QPR3	**How is the production on the subject of digital competencies and STEAM in education characterized?**

Regarding the production in relation to digital competencies and STEAM approach in education, of the total scientific production with open access (61 documents), according to the type of document a characterization can be made according to: published article (approximately 60. 6% of the documents), book chapters (representing 3% of the production), review articles (representing 6.6% of the production), early review (representing 14.8% of the production), conference review (representing 8.3% of the production) and meeting 6.7%, graph 6 shows the relationship of the documents according to their type.

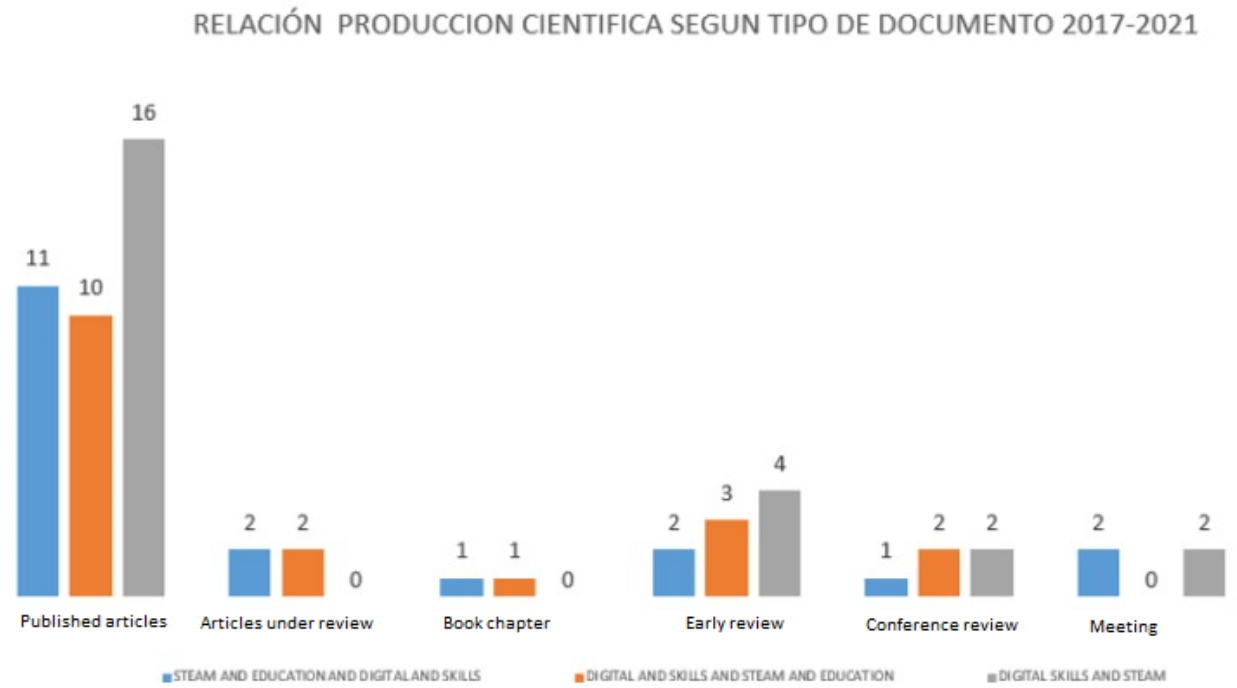

Figure6. Relation of scientific production. Source: own elaboration 2021.

This process provides an answer to question QPR3: How is the production of digital and STEAM competencies in education characterized?

QPR4	**In which languages and in which countries is research on the topic of digital competencies and STEAM in education being developed?**

According to the search process in the Web of Science and Scopus databases in the years 2017 and 2021, an increasing trend of 25 countries is evidenced, being the United States, South Korea, Taiwan, Finland, United Kingdom, Spain, Ukraine and China, the countries with the highest production, in terms of the established topics. Together, these countries contribute a total production of approximately 70%, with English being the predominant language in 93.6% of the documents, followed by languages such as Korean, Spanish, Portuguese, Turkish and Chinese.

QPR5	**Which are the journals with the highest number of publications about the research topic?**

In reference to the journals with the highest number of publications on the topic of digital competencies and STEAM approach in education in the time studied, the top 10 journals are listed with the respective quartile, name of the article, authors and year of publication.

Table 4. Categories of open access journals where most publications are made

Journal	Quartile	Article´s title	Authors	Year
Philippine Journal of Science	Q2	Technology integration traditions, transitions and best practices in higher education in the Philippines.	Morales, MPE, Avilla, RA, Butron, BR, (...), Masangcay, DB, Laureano, RA	2021
Research and development of educational technologies	Q1	We game on skyscrapers: the effects of an equity-based game design workshop on students' computational thinking skills and perceptions of computer science.	Çakır, NA, Çakır, MP, Lee, FJ	2021
International Journal of Child-Computer Interaction	Q1	Game jams in general formal education	Aurava, R., Meriläinen, M., Kankainen, V., Stenros, J.	2021
Research and development of educational technologies	Q1	Expectations and realities: examining the game jam experiences of adolescent students.	Aurava, R., Meriläinen, M.	2021
Eurasia Journal of Mathematics, Science and Technology Education	Q2	STEM and STEAM education in Russian education: conceptual framework.	Shukshina, LV, Gegel, LA, Erofeeva, MA, Chugaeva, UY, Nikitin, OD	2021
Computer applications in engineering education	Q1	Fostering STEAM through challenge-based learning, robotics, and physical devices: a systematic review of the cartographic literature.	Conde, M.Á., Rodríguez-Sedano, FJ, Fernández-Llamas, C., (...), Lima, J., García-Peñalvo, FJ	2021
Electrical engineering/computer science.	Q2	STEAM-based active learning approach for selected topics in	Zaher, AA , Hussain, GA	2020
Studies in Art Education	Q1	Teaching digital game design with art educators in training.	Patton, R., Sweeny, RW, Shin, R., Lu, L.	2020
International Journal of Emerging Technologies in Learning	Q2	Formation of design and research skills in future teachers within the framework of STEAM education.	Anisimova, TI, Sabirova, FM, Shatunova, OV	2020

ComunicazioniSociali	Q2	Taming monstrous play: Steam learning, maker culture, and monster-making media for children	Saienko, N., Olizko, Y., Arshad, M.	2018

Source: own elaboration

Table 5. Mapping production 2017-2021 on digital competencies and STEAM approach in education

No.	Article Data
1	Systematic mapping of the robosteam project: robotics and challenge-based learning Conde, MA ; Sedano, FJR ; (...); García-Penalvo, FJ. IEEE Global Engineering Education Conference (IEEE EDUCON) 2020 |Proceedings of the IEEE 2020 global engineering education conference (EDUCON 2020) , pp.214-221.
2	The influences of STEAM program using Infragram for plant health monitoring on creative problem-solving ability, science process skills, and affective mastery of elementary school students. Choi, Youngmi& Ho, ngSeung .2016 |Biology education 44 (1), pp. 72-86.
3	Development of tasks with artistic elements for teaching English engineers for specific purposes in the classroom. Saienko, N ;Olizko, Y and Arshad, M. 2019 | INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGIES IN LEARNING14 (23) , pp. 4-16.
4	Game Jams for learning and teaching: a review. Merilainen, M ;Aurava, R ; (...); Stenros, J. Apr-Jun 2020 | INTERNATIONAL JOURNAL OF GAME-BASED LEARNING10 (2) , pp. 54-71.
5	SCIENCE EDUCATION AS A BASIS FOR THE FORMATION OF INNOVATIVE SKILLS IN THE CONDITIONS OF DIGITAL TRANSFORMATION OF SOCIETYHrynevych, LM ; Morze, NV and Boiko, MA2020 | INFORMATION TECHNOLOGIES AND LEARNING TOOLS77 (3) , pp. 1-26
6	Formation of design and research skills in future teachers in the framework of STEAM education. Anisimova, TI ;Sabirova, FM and Shatunova, OV. 2020 | INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGIES IN LEARNING15 (2) , pp. 204-217
7	Expectations and realities: examining the game jam experiences of adolescent students. Aurava, R and Merilainen, M. October 2021 (early access) | EDUCATION AND INFORMATION TECHNOLOGY
8	THE USE OF GO-LAB PLATFORM TOOLS FOR THE DEVELOPMENT OF STUDENTS' RESEARCH SKILLS. Budnyk, O and Dziabenko, O. 2020 | INFORMATION TECHNOLOGIES AND LEARNING TOOLS80 (6) , pp. 1-20

9	Expectations and realities: Examining adolescent students' game jam experiences Aurava, R., Meriläinen, M. 2021 Education and Information Technologies
10	STEM and STEAM Education in Russian Education: Conceptual Framework Shukshina, L.V., Gegel, L.A., Erofeeva, M.A., (...), Chugaeva, U.Y., Nikitin, O.D. 2021 Eurasia Journal of Mathematics, Science and Technology Education 17(10), pp. 1-14
11	Digital learning ecosystem involving steam gamification for a vocational innovator Kummanee, J., Nilsook, P., Wannapiroon, P. 2020 International Journal of Information and Education Technology, 10(7), pp. 533-539
12	Robosteam - A challenge based learning approach for integrating STEAM and develop Computational Thinking Conde, M.A., Fernández, C., Alves, J., (...), Jormanainen, I., Pẽalvo, F.J.G. 2019 pervasivehealth: Pervasive Computing Technologies for Healthcare, pp. 24-30
13	Development of tasks with art elements for teaching engineers in english for specific purposes classroom Saienko, N., Olizko, Y., Arshad, M. 2019 International Journal of Emerging Technologies in Learning 14(23),1955
14	Craft- and project-based making for STEAM learning Montero, C.S. 2018 ACM International Conference Proceeding Series November 2018 Article No.: 31Pages 1–2https://doi.org/10.1145/3279720.3289237
15	Development of Tasks with Art Elements for Teaching Engineers in English for Specific Purposes Classroom Saienko, N; Olizko, Y and Arshad, M 2019 | INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGIES IN LEARNING 14 (23) , pp.4-16
16	Robosteam Project Systematic Mapping: Challenge Based Learning and Robotics Conde, MA; Sedano, FJR; (...); Garcia-Penalvo, FJ IEEE Global Engineering Education Conference (IEEE EDUCON) 2020 | PROCEEDINGS OF THE 2020 IEEE GLOBAL ENGINEERING EDUCATION CONFERENCE (EDUCON 2020) , pp.214-221
17	Enhancing 21st Century Skills with AR: Using the Gradual Immersion Method to develop Collaborative Creativity Sanabria, JC and Aramburo-Lizarraga, J Feb 2017 | EURASIA JOURNAL OF MATHEMATICS SCIENCE AND TECHNOLOGY EDUCATION 13 (2) , pp.487-501
18	Robosteam - A Challenge Based Learning Approach for integrating STEAM and develop Computational Thinking Conde, MA; Fernandez, C; (...); Penalvo, FJG 7th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM) 2019 | TEEM'19: SEVENTH INTERNATIONAL CONFERENCE ON

	TECHNOLOGICAL ECOSYSTEMS FOR ENHANCING MULTICULTURALITY , pp.24-30
19	SCIENTIFIC EDUCATION AS THE BASIS FOR INNOVATIVE COMPETENCE FORMATION IN THE CONDITIONS OF DIGITAL TRANSFORMATION OF THE SOCIETY Hrynevych, LM; Morze, NV and Boiko, MA 2020 | INFORMATION TECHNOLOGIES AND LEARNING TOOLS 77 (3) , pp.1-26
20	Robotization, Will Only Change Employment? Llorente, CL 2020 | REVISTA EMPRESA Y HUMANISMO 23 (1) , pp.9-33
21	THE USAGE OF GO-LAB PLATFORM TOOLS FOR THE DEVELOPMENT OF STUDENTS' RESEARCH SKILLS Budnyk, O and Dziabenko, O 2020 | INFORMATION TECHNOLOGIES AND LEARNING TOOLS 80 (6) , pp.1-20
22	Analysis of single board architectures integrating sensors technologies† Álvarez, J.L., Mozo, J.D., Durán, E. 2021 Sensors 21(18),6303
23	Expectations and realities: Examining adolescent students' game jam experiences Aurava, R., Meriläinen, M. 2021 Education and Information Technologies
24	STEM and STEAM Education in Russian Education: Conceptual Framework Shukshina, L.V., Gegel, L.A., Erofeeva, M.A., (...), Chugaeva, U.Y., Nikitin, O.D. 2021 Eurasia Journal of Mathematics, Science and Technology Education 17(10), pp. 1-14
25	Digital learning ecosystem involving steam gamification for a vocational innovator Open Access Kummanee, J., Nilsook, P., Wannapiroon, P. 2020 International Journal of Information and Education Technology 10(7), pp. 533-539
26	The effect of using STEAM approach on developing computational thinking skills among high school students in Jordan Bedar, R.A.-H., Al-Shboul, M. 2020 International Journal of Interactive Mobile Technologies 14(14), pp. 80-94
27	Development of tasks with art elements for teaching engineers in english for specific purposes classroom Saienko, N., Olizko, Y., Arshad, M. 2019 International Journal of Emerging Technologies in Learning, 14(23),1955
28	A review on complementary natures of tangible user interfaces (tuis) and early spatial learning Baykal, G.E., Alaca, I.V., Yantaç, A.E., Göksun, T. 2018 International Journal of Child-Computer Interaction,6, pp. 104-113

29	Enhancing 21st century skills with AR: Using the gradual immersion method to develop collaborative creativity Sanabria, J.C., Arámburo-Lizárraga, J. 2017 Eurasia Journal of Mathematics, Science and Technology Education 13(2), pp. 487-501

Conclusions

According to the systematic mapping of the state of the art carried out between the years 2017 to 2021, the production of 214 relevant articles related to the topics is evidenced, of which, 61 of them are open access and once the exclusion filters are applied, 29 research productions focused on the topic are obtained.

The units of analysis on digital competencies and STEAM approach are scarce, which makes it necessary to generate strategies to support research on these topics. It is also necessary to identify the lines of connection that allow the development of projects that link these areas.

This mapping provides the reader with an approach to the subject and allows the development of a route that achieves the exploration according to the research interests. In this study, metadata of the documents such as title, abstract and keywords were used, highlighting that the systematic mapping is the opportunity to have an overview of the existing production, by systematically exposing the research production on digital competencies and the STEAM approach in education. This will allow shaping the corpus and the topics that could be integrated, structuring new ways of work and development in the educational field.

Finally, being able to relate, link digital competencies, and the STEAM approach can provide teachers and students with strategies to solve specific problems in different situations and scenarios.

Referencias bibliográficas

Abellán Azorín, M. C. (2018). El método de aprendizaje cooperativo y su aplicación en las aulas. Perfiles Educativos |. http://www.scielo.org.mx/pdf/peredu/v40n161/0185-2698-peredu-40-161-181.pdf

Banet Hernández, E., Blanco López, Á., Carbó Cortina, V., & De Pro Bueno, A. (2009). Competencia en el conocimiento y la interacción con el mundo físico en Educación Primaria. Multiárea: Revista de Didáctica, 4, 51–74.

Buitrago, Á. R., Neisa, M., Mejía, M., Rubinsten, C., & Barbosa, H. (2013). La argumentación: de la retórica a la enseñanza de las ciencias Argumentation: from rhetoric to science teaching. Innovación Educativa. http://www.scielo.org.mx/pdf/ie/v13n63/v13n63a3.pdf

Chien, YH., y Chu, P. (2017). The different learning outcomes of high school and college students on a 3D-printing STEAM engineering design curriculum. International Journal of Science and Mathematics Education, 1–18. https://doi.org/. doi:10.1007/s10763-017-9832-4

Cilleruelo, L., & Zabiaga, A. (2014). STEM TO STEAM. https://www.augustozubiaga.com/web/wp-content/uploads/2014/11/STEM-TO-STEAM.pdf

Comisión de la Banda Ancha. (2019). Trusted universal connectivity and innovative partnerships to drive inclusive digital transformation. Rusted Universal Connectivity and Innovative

Partnerships to Drive Inclusive Digital Transformation, 2. www.broadbandcommission.org/about

Di Bernardo, J. (2004). Aprendizaje basado en problemas (ABP) en la Carrera de Bioquímica. Sus beneficios cognoscitivos desde la auto-evaluación. Universidad Nacional del Nordeste, Facultad de Ciencias Exactas y Naturales y Agrimensura.

Fernández March, A. (2006). Metodologías activas para la formación de competencias. | Educatio Siglo XXI. Revistas.Um.Es.

González, M. E. (2015). El b-learning como modalidad educativa para construir conocimiento. Red de Revistas Científicas de América Latina, El Caribe, España , 31, 501–531. https://www.redalyc.org/pdf/310/31045568029.pdf

Hernández, C. A. (2005). ¿Qu son als competneicas cientificas?30.

How, M., Loong, W., & Hung, D. (2019). education sciences Educing AI-Thinking in Science , Technology , Engineering , Arts , and Mathematics.

Land, M. H. (2013). Full STEAM ahead: The benefits of integrating the arts into STEM. Procedia Computer Science, 20, 547–552. https://doi.org/10.1016/j.procs.2013.09.317

López Simó, V., Couso Lagarón, D., & Simarro Rodríguez, C. (2018). Educación STEM en y para el mundo digital. Cómo y por qué llevar las herramientas digitales a las aulas de ciencias, matemáticas y tecnologías. https://www.um.es/ead/red/58/lopez_et_al.pdf

Marco, L. (2008). El aprendizaje basado en problemas. Una propuesta en el contexto de la educación superior. Tiempo de Educar, 9(18), 199–232.

Marín Díaz, V. (2015). La Gamificación educativa. Una alternativa para la enseñanza creativa. Digital Education Review, 27. https://doi.org/10.1344/der.2015.27.

Medina-Gamero, A. (2019). La virtualidad de la educación, un reto en el aprendizaje universitario. Reseña del libro de Claudio Rama, Políticas, tensiones y tendencias de la educación a distancia y virtual en América Latina. Revista Iberoamericana de Educación Superior, 10(29), 214–216. https://doi.org/10.22201/iisue.20072872e.2019.29.532

Morales Martínez, Y. M., & Dutrénit Bielous, G. (2017). El movimiento Maker y los procesos de generación, transferencia y uso del conocimiento. Entreciencias: Diálogos En La Sociedad Del Conocimiento, 1–29. https://doi.org/10.22201/enesl.20078064e.2017.15.62588

OECD-PISA. (2010). El programa para la evaluación internacional de alumnos (PISA) de la OCDE. Informe PISA 2009 Tendencias de Aprendizaje Cambios En El Rendimiento de Los Estudiantes Desde 2000, V, 218. https://doi.org/10.1787/9789264091580-en

Ortega, C., Passailaigue, R., Febles, A., & Estrada, V. (2017). El desarrollo de competencias científicas desde los programas de posgrado. Revista Electrónica de Veterinaria. http://www.veterinaria.org/revistas/redvet/n111117/111719.pdf

Ortiz-Colón, A.-M., Jordán, J., & AgredaI, M. (2018). Gamificación en educación: una panorámica sobre el estado de la cuestión SECCIÓN: ARTÍCULOS This content is licensed under a Creative Commons attribution-type BY-NC. Revista Da Faculdade de Educação , 44, 1–17. https://doi.org/10.1590/S1678-4634201844173773

Paredes, M. (2018). El aprendizaje activo, el aprendizaje basado en proyectos y la educación STEM. https://yoprofesor.org/2018/02/22/15-herramientas-para-un-mejor-aprendizaje-

Park, H. J., Byun, S. Y., Sim, J., Han, H., & Baek, Y. S. (2016). Teachers' perceptions and practices of STEAM education in South Korea. Eurasia Journal of Mathematics, Science

and Technology Education, 12(7), 1739–1753. https://doi.org/10.12973/eurasia.2016.1531a

Quintana, J., Elola, J., & Máximo, L. (2008). Las competencias Básicas en el área de Ciencias. https://diversidad.murciaeduca.es/orientamur/gestion/documentos/cuadernos_educacion_4.pdf

Santiago Juárez, R. (2010). Crisis of legitimacy of democratic institution. 33, 1–25. http://www.scielo.org.co/pdf/dere/n33/n33a10.pdf

Segarra, V. A., Natalizio, B., Falkenberg, C. V., Pulford, S., & Holmes, R. M. (2018). STEAM: Using the Arts to Train Well-Rounded and Creative Scientists. Journal of Microbiology & Biology Education, 19(1), 1–7. https://doi.org/10.1128/jmbe.v19i1.1360

Silva Quiroz, J., & Castillo, D. M. (2017). A proposal of a Model for the introduction of active methodologies in Higher Education. Innovación Educativa, 17, 1–15. http://www.scielo.org.mx/pdf/ie/v17n73/1665-2673-ie-17-73-00117.pdf

Simanca Herrera, F. A., Abuchar Porras, A., & Velazco, S. Y. (2017). Las TIC y el aprendizaje de los trinomios. Redes de Ingeniería, 199–207. https://doi.org/10.14483/2248762X.12492

UNESCO. (2018). Las competencias digitales son esenciales para el empleo y la inclusión social. https://es.unesco.org/news/competencias-digitales-son-esenciales-empleo-y-inclusion-social

Valles, Miguel, S. (1999). Tecnicas cualitativas de investigación social. https://metodologiaecs.files.wordpress.com/2014/11/vallesmiguel-tc3a9cnicas-cualitativas-de-investigacic3b3n-social-1999.pdf

Van der Linde, G. (2014). ¿Por qué es importante la interdisciplinariedad en la educación superior? Cuaderno de Pedagogia Universitaria, 4(8), 11–12. https://doi.org/10.29197/cpu.v4i8.68

Wang, X., Xu, W., & Guo, L. (2018). The Status Quo and Ways of STEAM Education Promoting China's Future Social Sustainable Development. In Sustainability (Vol. 10, Issue 12). https://doi.org/10.3390/su10124417

Watson, A., & Watson, G. (2013). Transitioning STEM to STEAM: Reformation of Engineering Education The acronym STEM was coined in 2001 Transition From STEM to STEAM. www.asq.org/pub/jqp

Yakman, G. (2008). Association for the Advancement of Science. NAE. https://steamedu.com/wp-content/uploads/2014/12/2008-PATT-Publication-STEAM.pdf

Yakman, G., & Lee, H. (2012a). STEAM Education View project Global Languge View project. J Korea Assoc. Sci. Edu, 32, 15. https://doi.org/10.14697/jkase.2012.32.6.1072

Yakman, G., & Lee, H. (2012b). Exploring the Exemplary STEAM Education in the U.S. as a Practical Educational Framework for Korea. Journal of The Korean Association For Science Education, 32(6), 1072–1086. https://doi.org/10.14697/jkase.2012.32.6.1072

Zollman, A. (2012). Aprendizaje para la alfabetización STEM: Alfabetización STEM para el aprendizaje. Asociación de Ciencias Escolares y Matemáticas, 12–19. https://doi.org/https://doi.org/10.1111/j.1949-8594.2012.00101.x