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Students' Engagement through Technology and Cooperative Learning: A Systematic Literature Review

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Abstract

Students' engagement (SE) is an inherent part of learners' participation in a classroom instructional task through different and diverse activity-based media. This paper analyses a logical literature of SE with cooperative learning (CL) and technology integration (TI). The outcomes reveal the impact of instructional methodology such as active learning through cohort instructions to generate conceptual understanding and SE, critical thinking, and student-centred activities, blended and flipped learning, Google Docs (a free Web-based tool that allows you to create, edit, and store documents online), and massive open online course (MOOC) to improve student homework. The systematic review of the literature establishes outcomes from current research conducted between January 2013 and June 2022. Out of 114 papers, thirty publications fulfilled the refining and exclusion/inclusion guidelines after standard evaluation screening of the journals and review, along with the additional elimination of repetitive records from the study. The goal of the evaluation is to analyse the effectiveness of all the papers utilised in the research. The literature review possibilities are illustrated by the preferred reporting items for systematic reviews and meta-analyses (PRISMA) framework. The limitations and discussion from this systematic literature review (SLR) address some gaps, future directions for SE, and implications for education and research.

Keywords: Students' Engagement, Technology, Cooperative Learning, Systematic Literature Review.

1. Introduction

1.1 Students Engagement

In recent decades, mathematics education research has centred on primary and secondary students' vigorous participation in mathematical learning. Although education disruption arises (Koch and Vogt, 2015; Kaewunruen, 2019; Liu, 2021) due to the pandemic by posing a major challenge for the global community, and the adverse effects of school closures as well as the compounding issues related to the pre-existing global learning crisis (Liu, 2021). Engagement among students is more important than any instructional issue. We therefore carefully explore this mediating relationship, which is projected to be a mediator of the influence of the learning environment on student learning, especially in the context of secondary school. Additionally, student involvement can pave the way for important educational outcomes like learning, advancement in the classroom, and success (Shernoff et al., 2017). The traditional lecture model replacement with one that stimulates good student interactions to adopt active learning in mathematics classes is vital. Mathematical communication standards, for example, to encourage students to participate in mathematics by explaining to peers, conjecturing, or justifying their answers (Aliyu et al., 2021; Morgan et al., 2018; Reynolds, 2019). Calculative thinking, written reflections, and individual task work are constructive intra-student input during active learning. Students may work on projects that focus on methods, applications, or concepts, but each allows for active learning (Boyce & O'Halloran, 2020). Students' participation has a significant impact on academic progress and involvement in subjects such as maths and is enhanced or diminished depending on the learning context. This avenue of investigation emphasises on mechanisms forming mathematical understandings in the mathematics education literature. Mathematical involvement is becoming more widely recognised as means to which students' exam performance and participation in STEM-related disciplines are achieved (Watt et al., 2017). Student participation encompasses academic, behavioural, cognitive, and psychological aspects. As a result, student engagement relates to the degree to which students and the school environment are a good fit, and it is more meaningful when regarded as a process that occurs throughout the school year. Indeed, understanding the mechanisms and processes that aid in school adjustment and development may improve learners' participation and achievement (Liem and Chong, 2017). Thus, the goals are to map out the current state of knowledge on the problem based on the specified topic. The Systematic review (SR) aims in revealing a comprehensive and scholarly investigation that provides clear answers to research questions and is presented through the careful process in an explicit manner. The SLR aims to answer the main research questions:

1) What are the conclusions of the studies on technology intervention and SE? 2. What were the outcomes of earlier SE and CL studies?

1.2 Technology Use

A recent assessment of empirical data on the use of digital technology in mathematics education found that technology use does not always live up to its potential to improve the learning experience. Students use digital technologies (creatively) less frequently in educational settings than in everyday contexts, according to research, and digital tools in education are frequently employed to support traditional activities (Viberg et al., 2020). Weinhandl et al., (2021) showed some benefits of technology use in mathematics classrooms, particularly when constructivist teaching and learning methods are used. Ramatlapana, (2014) came to the realization that online mathematics courses may be as beneficial as face-to-face and that, in some research, learners in online mathematics courses outperformed learners in conventional mathematics classes in terms of learning outcomes. Wijaya et al., (2020) argue that technology explores new knowledge, promotes deductive reasoning with skillful application, has diverse applications, expands new knowledge, affords blueprint summaries, and assists students to understand abstract learning. Also, Botana et al., (2015) argue that technology promotes learning comprehension and assists learners in describing and bridging between challenging difficulties and generated queries.

1.3 Cooperative Learning

Cooperative learning (CL) is a teaching technique in which students collaborate in groups of varied sizes to achieve common goals (Esan, 2015). CL allows students to collaborate and assist one another to achieve higher academic goals than individualistic or competitive learning (Edem, 2019). While conventional learning does not train students to communicate and be adept in utilising computers, cooperative learning has pushed students to work together in particular group tasks in discussions, debates, or additional lectures (Ningsih et al., 2019). Topuz and Birgin, (2020) stressed that cooperative learning environment is suitable for students' query skills in geometry, and. instead of memorising material, students should actively explore it, become more interested and motivated in the lesson, and boost the persistence of their learning. Bayaga et al., (2019) argue that cooperative learning is consistently acknowledged as an effective pedagogy for learning mathematics.

1.4 Systematic Literature Review

Aliyu et al. (2021) stressed that the SLR technique is about searching, finding the proper type of study, submitting a query, and retrieving information from the articles, all of which should be part of the SLR process. Following that, the review's conclusions should be concise, and the assessment's framework should be made public. All document evaluations should contain the mediation and pattern results (Aliyu et al., 2021).

As a result, the conclusions under the PRISMA framework synthesise the available evidence. The outcomes are always classified. For searching tactics and reporting, SLR has a well-defined procedure. It's important to get rid of duplicates from the file records. The research questions were informed and raised through the SLR. There were justifications for including and excluding studies. Data were gathered from recent and relevant studies on the subject at hand and followed up with the quality of the review based on the included studies.

The segments below explain all of the research's content in ascending order: Technique, exploration strategies, collection condition, value review, removal of data, results (Study of Students' Engagement through Technology and Cooperative Learning, and a summary of thirty review papers), Limitations, Discussions (Future Recommendations and Research Implication), and References

2. Technique

High-quality scientific information is presented through systematic literature reviews (SLR) based on specific subjects. SLR's priority is to be as unbiased, fully transparent, and consistent as necessary. SLRs are a well-known scientific proof paradigm framework that have gained significant validity in research disciplines in recent years, including medical, engineering, social sciences, and education (Bano et al., 2018). Also, SLR is a method of classifying and integrating results that meet specified criteria to accomplish tasks. It is a method of formulating a precise query that employs rationality and techniques in categorising, analysing, and, most importantly, evaluating or measuring significant exploration, as well as gathering and analysing data according to the review's findings. SLR aims to identify, analyse, and develop accurate provision that brings together established suitability events to a given investigative problem (Aliyu et al., 2021). Figure 1 depicts the inclusion and exclusion of literature at each stage:

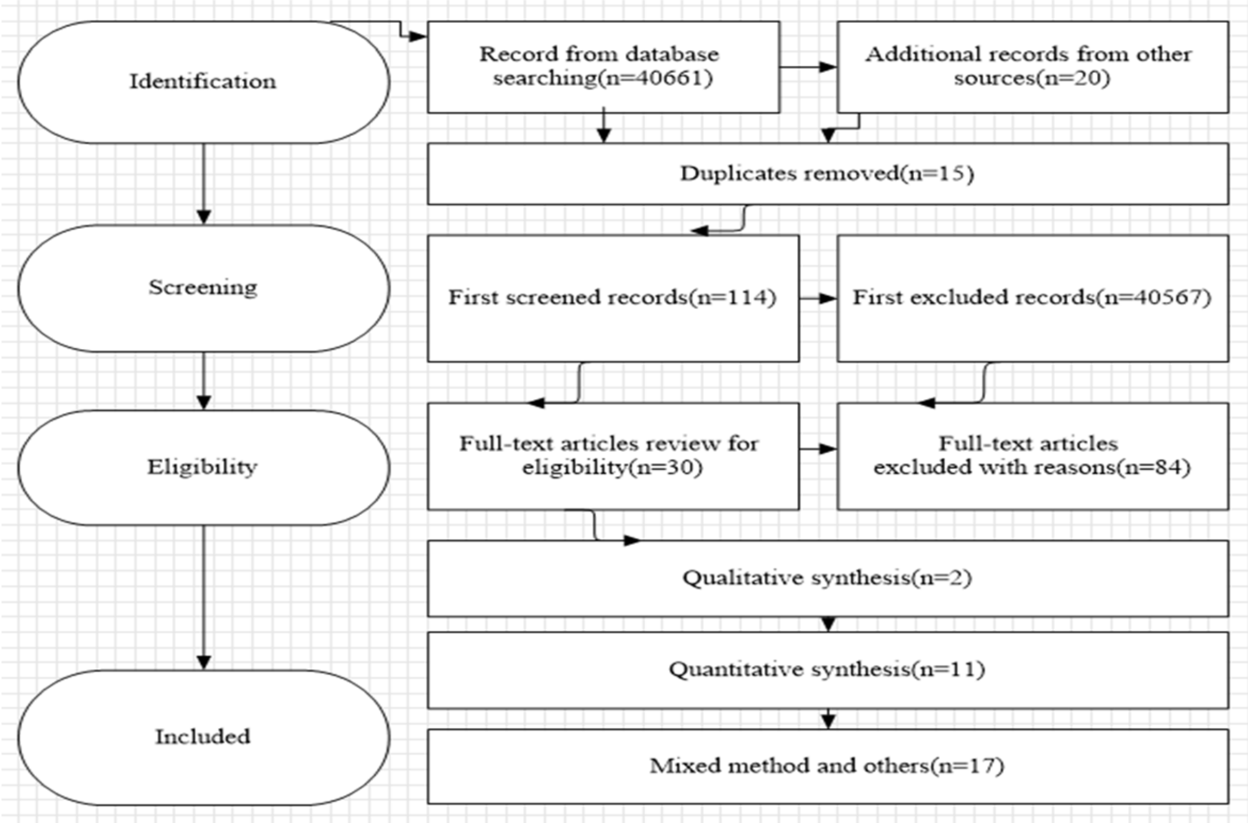

Figure 1. An Overview of literature exclusion and inclusion

2.1 Exploration Strategies

A search strategy was devised to locate relevant articles for this systematic search: Engagement OR SE AND Technology OR cooperative learning in Mathematics and Science Education. Taylor & Francis Online, Science Direct or Elsevier, JSTOR, Scopus, and Web of Science were employed in these search techniques. Furthermore, Google Scholar and Taylor and Francis were used as one of the best websites that allow unlimited publishing platforms for encyclopedic articles in several areas, including educational transdisciplinary research. All searches covered the period from January 1, 2013, to June 15, 2022, and only included journals and reviews published in English.

2.2 Collection Conditions

The exploration primarily concentrated on identifying the body of literature in the field of social sciences on students' engagement (SE) with cooperative learning (CL) and technology integration (TI). With almost 40,661 papers, the test then limited to subject areas, including social sciences, art, humanity, multidisciplinary, and technology. Exploration took place between 2013 and 2022. All works published before the 2013 review were excluded. The investigation includes all countries in the world. A total of 40,567 research publications were presently eliminated from the work; the research uses an extracted record of 114.

2.3 Value Review

New research articles and review papers are the focus of the study. For credibility purposes, all duplicated papers were removed from the analysis. Consequently, to support the quality and importance of instructional materials in the investigation technique, the abstracts of the papers were then rigorously verified and followed up with evaluation and purification. As a result, a thorough review of each article was carried out over a period of time. The refusal process included all documents not published in English. There were fourteen in other languages which were removed from the study. In addition, 55 papers were refined and then eliminated, and 15 more duplicated publications were excluded from the study or filtered. Thus, 30 papers were chosen to evaluate all the articles against the addition and removal conditions.

2.4 *Removal of Data*

The results were confined to only review papers and journals from 2013 to June 2022, and they were only available in English. During the review, a total of 114 publications were included for the study's goals. The following include the keywords related to student engagement with cooperative learning and technology: (i) Students engaged constructively with their peers on group tasks, made claims, and compared their findings with one another (Gillies, 2020). (ii) Student satisfaction with learning and engagement improved when the flipped classes were used fully online (Swart, 2021). (iii) Lack of sufficient mathematical knowledge and achievement leads to disengagement and drop-out (Gallimore and Stewart, 2014). (iv) Student assessment can determine the efficiency of the student's engagement (Putwain et al., 2017). (v) Student perceptions about team-based learning, and how to measure team learning framework (Alvarez-Bell et al., 2017). (vi) Integration of Google Docs in facilitating undergraduate students' collaboration in an online course (Gallimore and Stewart, 2014; Ali, 2021). (vii) Flipped learning and student questions have a constructive impact on students' enthusiasm, attitudes, and commitment (Su and Chen, 2018). (viii) Differences exist between the MOOC completers and non-completers (Lan and Hew, 2020). In informing the review, the authors discarded all of the publications that did not meet the criteria after compiling the content into a table; 30 papers were thoroughly reviewed. The following is a summary of the findings and discussion.

3. Results

The discussion of the results is twofold, first based on literature classification from the SLR and discussed with the help of tables. Second, through descriptive analysis of the database information and follow-up with the deliberation of the outcome from the limitation section below. In this finding, there are few studies based on the primary and secondary schools' echelons. Thus, the results in the SLR are higher institutions based. Also, the students at lower levels require active student engagement for their learning achievement, logical thinking, and creative and basic skills for a solid foundation. Also, Lawrence et al. (2021) argues that there is need of accessible and initiative-taking intervention for students' capacities in engaged learning. Schell and Butler (2018) argue that cohort instruction generates conceptual understanding, problem-solving, and student engagement. Also, Lynch et al. (2013) stressed that the outcome features the negative influence of task difficulty on pupils' desire. Similarly, encouraging student engagement and inspiring students to take a degree in STEM (Koch and Vogt, (2015). There is a need to understand the students' insights towards collaborative learning and its effectiveness (Lan and Hew, 2020; Swart, 2021). The detailed information is given in Table 1 below:

Table 1. Study of students' engagement with cooperative learning

Citation	Instrument SE&CL	Results
(Lynch et al., 2013)	Homework & engagement	The outcome features tasks activity.
(Gallimore & Stewart, 2014)	Dropout& engagement	Lack of sufficient mathematical knowledge
(DeWaelsche, 2015)	Engagement critical thinking	critical thinking and student centered
Martin,2016	Science& constructivism	Outreach practitioner &constructivism
(Putwain et al., 2017)	Bahavioural; emotional fear appeal	Student assessment & engagement
(Alvarez-Bell et al., 2017)	Engagement, team learning	Perception about team-based learning
(Schell & Butler, 2018)	Active learning cognitive instructional &peer strategies	Cohort instruction generate conceptual understanding, and student engagement
(Martin, 2018)	Active learning cooperative	Individual questions collaborative skills
(Gillies, 2020)	Dialogue, discourse; inquiry	Students engaged with group tasks
(Swart, 2021)	Distance education and online	Flipped classes were move fully online
(Annamalai et al., 2021)	Collaborative learning; fun learning; gamified learning	Internal students' engagement in non-technology gamified learning
(Slof et al., 2021)	Collaborative learning; student engagement	Differences between and within-group regarding engagement
(Ambusaidi et al., 2021)	Constructivism, reform	Focused on reform-oriented learning
(Öncü & Bichelmeyer, 2021)	Cooperative; engagement; instructional practice	Instructional practices in the Cisco certified Network Associate (CCNA)
(Wei, 2021)	Innovative approach; flipped classroom	Effect on student engagement and student classes interaction.
(Lawrence et al., 2021)	Online learning; student engagement	Accessible and proactive intervention for students' engagement learning.

The majority of the authors from the table above stress the significance of engaging students through activities and having them work exceptionally hard to complete tasks that will help them succeed in their learning, particularly those that involve teamwork, innovative methods, student-centeredness, and critical thinking. The results also show that some students lack mathematical expertise, which causes them to lose interest and drop out. Thus, Table 2 summarises students' involvement with the use of technology:

Table 2. Study of students' engagement with technology

Citation	Instrument SE &Technology	Results
(Heaslip et al., 2014)	Engagement; homework; student performance; task difficulty.	The conclusion investigates the causes of student answers.
(Koch & Vogt, 2015)	University teaching; student engagement.	Encouraging student engagement & inspiring STEM
(Su & Chen, 2018)	and student question; Flipped learning	Flipped learning and student question based on enthusiasm, attitudes & commitment
(Kaewunruen, 2019)	Interactive technology; teaching approaches; students' engagement	Technology enhances students' engagement &intrinsic motivation
(Lan & Hew, 2020)	Engagement, psychological needs, & MOOC	Differences exist between the MOOC completers & non-completers.
(Dass et al., 2021)	Collaborative& engagement	Understanding student collaborative learning
(Lavonen et al., 2021)	Gender differences; learning; student situational interest	How classroom activities, student gender, & student personnel interest.
(Ali, 2021)	Engagement; Google Docs	Integration of Google Docs in an online
(Thiruvady et al., 2021)	Allocation& placement	Needs for Universities to support work & strengthen student learning skills
(Bond et al., 2020)	Student engagement, Systematic review, evidence map	Most of the studies lack student engagement definition with popularity in MOOC research
Chung et al., 2021)	Augmented reality; collaborative	Augmented reality (AR) assists students
(Alkhannani, 2021)	Problem solving discussion	cooperative learning & satisfaction
(Syarifuddin & Atweh, 2022)	Engagement; Mathematics	The ACE& student engagement
(Boateng et al., 2022)	Engagement via Mathematics; student group collaboration	Concept of self-directed learning& constructivism theories

Most of the authors in the table above stress the value of student engagement through various tools to further technological advancement and how these tools are shared in the digital age to encourage learner engagement based on novel concepts. The results also show differences between tasks accomplished with and without the assistance of technology based on gender, interest, and the support resources needed to boost the learning engagement process. Table 3 shows an overview of the articles for this systematic review:

Table 3. A summary of 30 evaluated studies

Researcher & year	Issue	Source title	Results
(Lynch et al., 2013)	3	Educational Research	Quantitative
(Gallimore & Stewart, 2014)	2	Teaching Mathematics Applications	Mixed method
(DeWaelsche, 2015)	-	Linguistics Education	Qualitative
(Jeong et al., 2019)	14	Internal Journal of Science Educ	Mixed method
(Putwain et al., 2017)	-	Teaching &Teacher Education	Mixed method
(Alvarez-Bell et al., 2017)	2	Teaching& Learning Inquiry	Quantitative
(Schell & Butler, 2018)	-	Frontiers in Educ	Empirical
(Martin, 2018)	4	Internal Journal of Higher Educ	Quantitative
(Gillies, 2020)	1	Education Sciences	Mixed method
(Swart, 2021)	3	Journal of Higher Educ	Quantitative
(Annamalai et al., 2021)	10	Theory &Practice	Quantitative
(Slof et al., 2021)	1	Qualitative Report	Qualitative
(Ambusaidi et al., 2021)	1	Journal of Computer Assisted Learning	Mixed method
(Öncü & Bichelmeyer, 2021)	3	Athens Journal of Educ	Quantitative
(Wei, 2021)	-	Participatory Educational Research	Mixed method
(Lawrence et al., 2021)	2	Frontiers in Psychology	Mixed method
(Heaslip et al., 2014)	1	Student Success	Mixed method
(Koch & Vogt, 2015)	2	Active Learning in Higher Educ	Mixed method
(Su & Chen, 2018)	6	Psychology Learning Teaching	Quantitative
(Kaewunruen, 2019)	2	Eurasia Joun. Of Math, Sci & Tech Educ.	Quantitative
(Lan & Hew, 2020)	1	International Joun. of Edu. Tech. in Higher Edu	Mixed method
(Dass et al., 2021)	3	Joun. of Eng. Transformation	Quantitative
Lavonen et al., 2021	16	International Joun. of Science Educ.	Quantitative
Ali, 2021)	-	Journal of Information	Mixed method
(Thiruvady et al., 2021)	8	Algorithms	Quantitative
(Bond et al., 2020)	1	International Joun. of Edu. Tech. in Higher Edu	Systematic evidence
(Chung et al., 2021)	5	Australasian Joun. Of Edu. Technology	Mixed method
(Alkhannani, 2021)	10	Theory & Practice	Mixed method
(Syarifuddin & Atweh, 2022)	1	European Joun. of Sci. & Math Edu	Mixed method
(Boateng et al., 2022)	1	Cogent Social Sciences	Qualitative

There are studies and articles backing up this assessment's conclusions, which are based on students' interaction with CLS and technology. Thus, the outcome shows eleven quantitative, three qualitative, fourteen mixed-method, one systematic literature review and one empirical research findings.

3.1 Limitations

A diverse range of countries is considered and nominated for this inquiry. Therefore, primary schools and secondary schools have fewer research studies than higher institutions with respect to these findings. Several investigations were undertaken through different backgrounds (Daoud et al., 2020), whereas some utilized various learning philosophies with same environment (Aliyu et al., 2021). Figure 2 summarises the scenario for each country or territory:

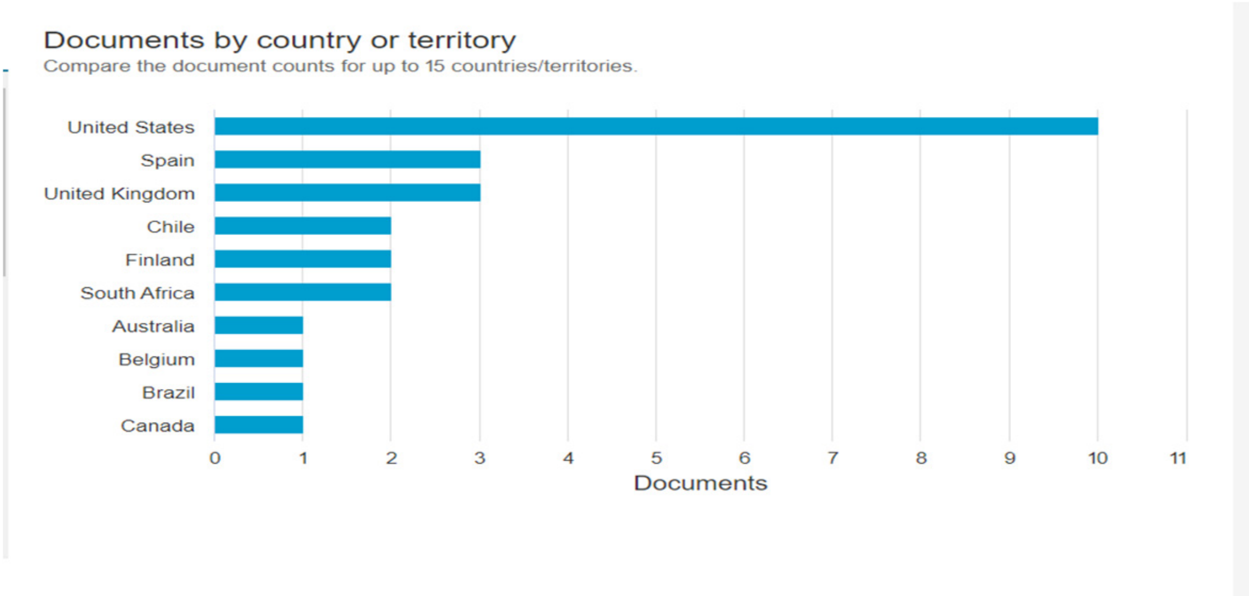

Figure 2. Documents by country or territory

The most scrutinised countries were the United States, Canada, Spain, the United Kingdom, and Sweden, with South Africa meeting all criteria in one database. According to the various data sources analysed, no findings matched the inclusion provisions from Africa. Document by type is illustrated in Figure 3 below:

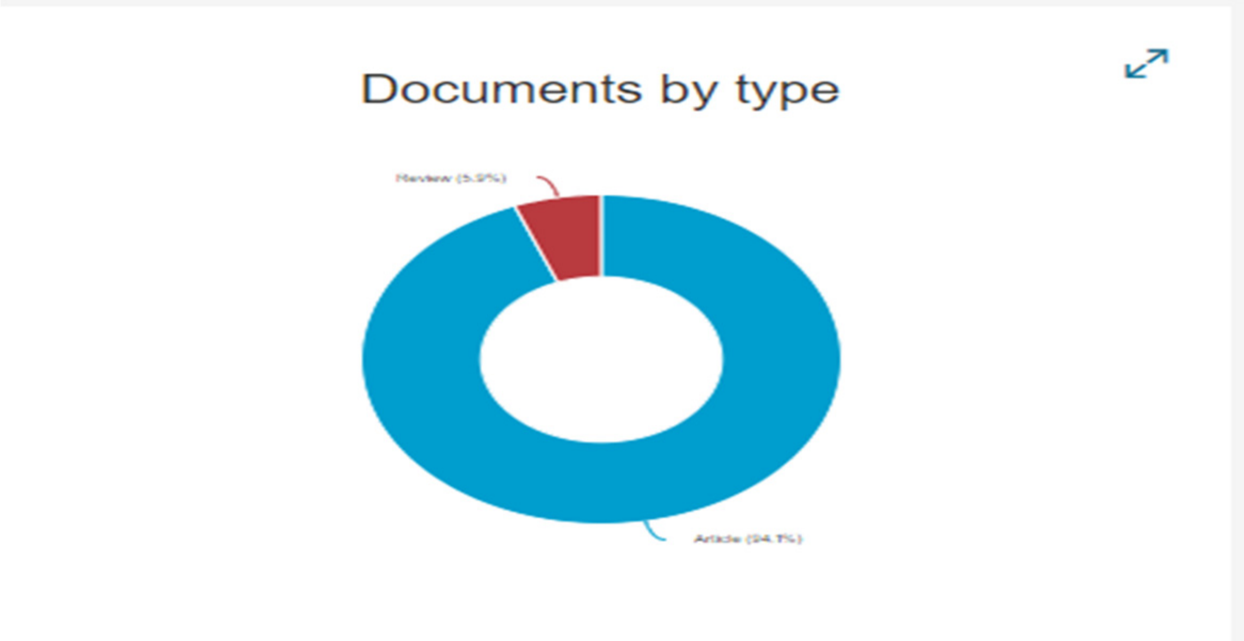

Figure 3. Document by type

The information with respect to document by type indicates 94.1% for completed journal articles from the database and only 5.9% for the articles under review in red, as illustrated in figure above. This shows that most of the extracted documents are directly from the concluded journal articles. Document by subject area is exemplified below:

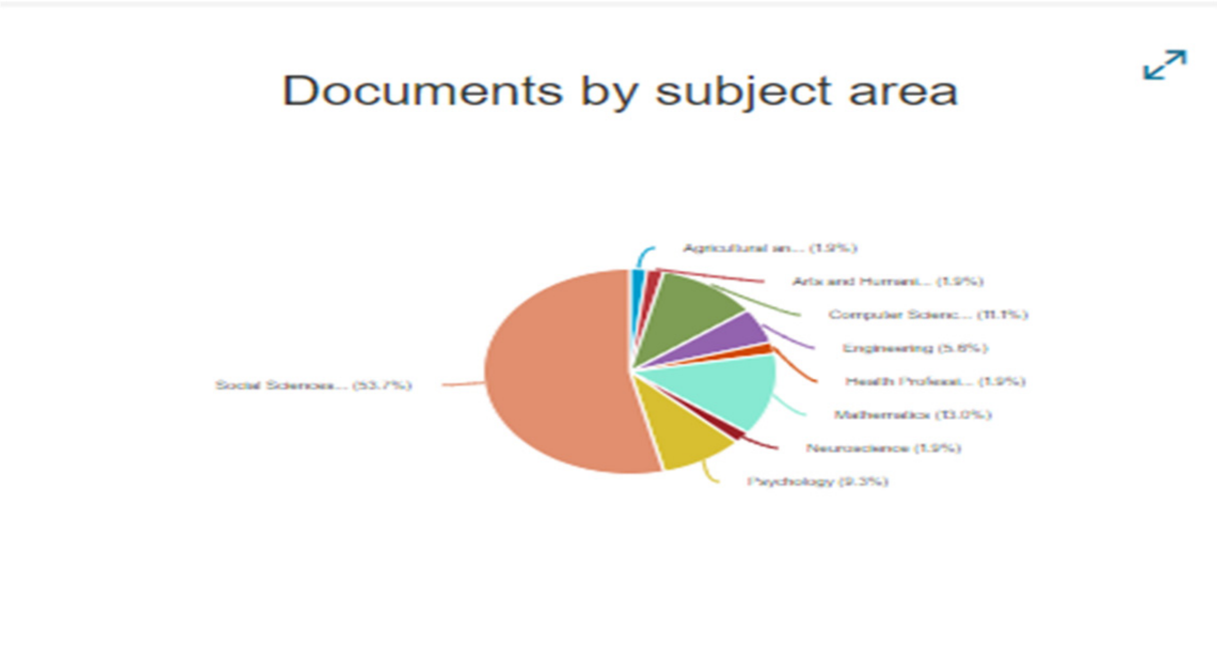

Figure 4. Information sorted by subject area

Mathematics accounted for only 13.0% of the total, whereas social sciences accounted for 51.7%. As seen in Figure 4 above, there is a demand for additional article writers in the discipline of mathematics. The review's articles recognised and provided information on document aspects by subject area and follow-up with document by year as illustrated in Figure 5 below:

Year ↓	Documents ↑
2022	3
2021	8
2020	11
2019	3
2018	5
2017	2
2016	0
2015	0
2014	2

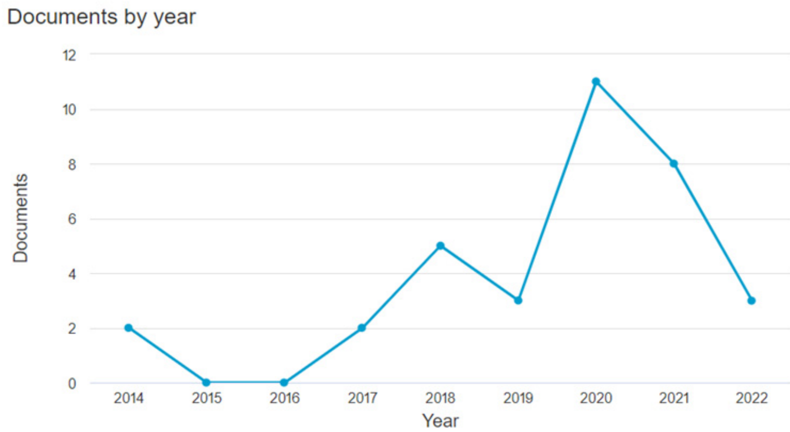

Figure 5. Year-by-year documents

Furthermore, documents by year show that there were zero records in 2015 and 2016, just two in 2014 and 2017, no documents in 2013, three papers in 2019 and 2022, five papers in 2018, and eight papers in 2021. Thus, the result of the data clearly shows that there are just a few writers, about 32 from 2014 to 2022 based on the documents by year. Also, document per year by source is given in Figure 6 below:

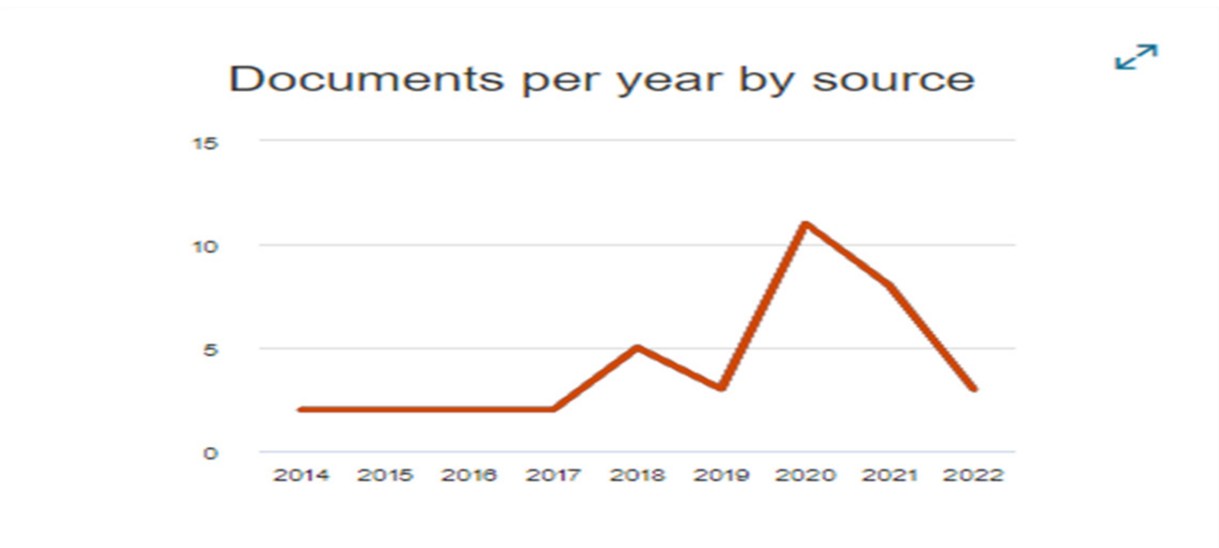

Figure 6. Document per year by source

Furthermore, between 2014 and 2017, there were few recordings of less than five documents per year by source. In 2018, the graph decreases to less than five, and in 2019, it again drops to less than five. Then, the graph rises to a peak of 11 in 2020, then drops to around seven in 2021 and three in 2022.

4. Discussion

The comprehensive literature report demonstrates that research around CLS and GG concentrates on constructivism learning activities with and without technology and in conjunction with students in pair and small groups as well as poor focus on primary and secondary with much emphasis on tertiary institutions of learning.

Therefore, other areas of study must be prioritised, such as topics in algebra and geometry through fun and play for SE, solving conic section with and without technology use, and complex numbers. Alternative approaches such as blended learning, flipped learning, Google Docs and MOOC can change the students' engagement scenarios and reduce learning difficulties and student drop out from the schools. Similarly, technology integration with CLS may develop and improve SE, its quality and reveal additional details.

SE's impact on educational theory and policy is progressive and essential to improving students' capacity for critical thought, teamwork, and think-pair-share activities that may help them understand content information better. Critical thinking, technology, communication, confidence, and SE catalyse excellent classroom participation in activities. Thus, the use of student-centred activities, through MOOC, blended and flipped learning and the Google Docs can redeem student homework activities to enhance students' success in mathematics knowledge. Technology is a dynamic and adaptable phenomenon that raises and supports students to transform complex understanding via multiple representation and visualisation of activities. The SE with CLS may assist the learning process and evaluate specific content knowledge, skills, and the approach in which students build their problem-solving competencies. SE ensures learners' success based on their capability to link mathematics with teacher preparation, sustain, and reinforce the integrity, and quality of instruction, making it favourable to learners. Encouragement of SE in the educational process may aid the development of a solid knowledge base. SE research indicates knowledge shifts and assimilation in practice and theory and requires exploration for further findings.

The goal of this study was to assess the CLS using technology from students' engagement (SE). The situation uses a modified PRISMA framework to demonstrate the literature review arising from the information extraction, performance evaluation, criteria for choosing, and exploration approaches. Thirty out of 114 papers matched the criteria assigned. In this paper, only completed articles journals and a few review papers in English language for data and from past investigations were used. The outcomes of CLS with technology were positive. Also, the research methodology assessment findings were justified in the summary of the reviewed publications. The review's goals and limitations, suggest future directions for further investigation would include whether different SE may shape and enhance mathematics learning. Consequently, in this study, most of the authors concentrate on higher institutions of learning, with only a few focusing on primary schools and secondary education.

Moreover, papers organized by nation, citations, subject area, and year reveal areas of weakness and suggest that research on such topics is limited. Thus, the results indicate a potential idea for CLS and technology integration.

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