Exploring the Use of Social Media in Engineering Education—Preliminary Findings from a Systematic Literature Review

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Abstract

Social media is an interactive platform that allows individuals to share their ideas, beliefs, and information to express their thoughts and opinions on different aspects. Social media has been gaining recognition and acceptance in engineering education, and it has been shown to increase student participation, engagement, and learning. To create guidelines for the effective use of social media platforms in engineering education, this theory paper primarily focuses on analyzing the various research studies done in the field by summarizing the different research topics, elements of social media used, and analysis techniques, among others. The articles for this study have been retrieved from various databases, including Scopus, Science Direct, Web of Science, Wiley Online Library, ERIC, IEEE Xplore Library, and Google Scholar. As a part of this literature search, the search phrases used to retrieve articles from these databases are Facebook + Engineering, Instagram + Engineering, and Twitter + Engineering.

The review process involved five distinct steps. Initially, all articles from various databases were gathered and compared to eliminate any duplicates, resulting in a total of 1821 articles. Articles that met the exclusion criteria, such as those published before 2017, articles not focused on engineering, articles in languages other than English, articles with a focus other than Facebook, Instagram, and Twitter, and work-in-progress articles, were removed from the final list. In the second step, these 1821 articles were screened based on their titles and abstracts to assess their relevance and applicability to the study. Out of these, 65 articles were selected for further consideration. Articles not meeting the relevance and applicability criteria were excluded from the study. In the third step, the remaining 48 articles were screened based on their full text to ensure they met the exclusion criteria. In the fourth step, the 21 articles that remained were critically reviewed to extract the relevant information necessary for the analysis. Information such as research questions, research design, data collection, and data analysis, among others, were retrieved from the articles and consolidated in a separate file. Finally, this consolidated information was further analyzed and synthesized to generate observations and trends. The findings indicate that Facebook, Instagram, and Twitter have been used as a learning environment in a few engineering disciplines, including software engineering, civil engineering, mechanical engineering, and electronics engineering. More than half of the sampled articles used quantitative research designs and descriptive statistics for data analysis, and Facebook emerged as the most preferred choice of researchers among the sampled articles.

Introduction and motivation

More than 40 million students use social media, a technology that encompasses various social networking sites like Facebook, Twitter, LinkedIn, Instagram, etc. [1]. Recent research has demonstrated how to use network science concepts and data-driven methodologies to quantify social influences in social media [2]. Due to the ease and ubiquity of Social Media tools and ease of accessibility via a laptop, smartphone, or tablet, an increasing number of students are using them [3]. Students can interact with current and previous peers through social media, which also makes it easier to access emotional support and suggests creative activities [4]. This is crucial

because, for minority students, making connections is one of the essential components of a fulfilling academic experience. Due to communication barriers or other reasons, minority students are typically less comfortable discussing their thoughts and experiences, so integrating social media platforms encourages the exchange of perspectives more effectively and without discomfort [5]. Despite these advantages, social media integration in education is hampered by several technical challenges, a lack of interest, and privacy concerns. As a result, efficient strategies for integrating social media into STEM disciplines must be developed to improve students' learning and engagement [6].

The increasing prevalence of social media platforms (SMP), like Twitter, Facebook, Instagram, etc., in students' daily routines has prompted research into the tangible effects of SMPs use in an academic context. Scholars have been collecting evidence to determine whether SMPs can be utilized as a teaching tool [7]. Although many educators are optimistic about SMP's educational potential, researchers are still conducting experiments to ascertain whether students' learning habits have changed due to SMP and the connection between SMP usage and academic performance [8]. Depending on the type of SMP, users can interact with it by adding friends, publishing interesting links, tagging other users in their posts or status updates, leaving comments, liking other users' posts, privately messaging their connections, and in a variety of different ways. Within these SMPs, user interactions aid in developing a user relationship network that represents ties of direct social impact.

The use of social media in engineering education has also been on the rise in recent years, and it has become a popular tool for students and instructors to connect, collaborate, and share information [9]. While some researchers argue that social media can enhance student engagement and learning, others suggest that its use may negatively impact learning outcomes[10]. Studies have investigated the impact of social media on engineering education and have found mixed results. A study conducted by [11] showed that social media platforms such as Twitter and Facebook improve student engagement, as students were more likely to participate in class discussions and share course-related information on these platforms. However, another study by [12] found that the use of social media had no significant impact on student engagement or academic performance. Furthermore, some researchers have expressed concern about the potential distractions that social media can cause during class time. Some studies [7, 13] found that using Facebook during class time was associated with lower academic performance, as students were more likely to multitask and lose focus on the lecture content. Despite the mixed findings, it is clear that social media is changing the way engineering education is delivered and received [14]. As more educators incorporate social media into their teaching practices, it will be essential to continue exploring the impact of social media on student learning and engagement and to identify strategies to maximize the benefits and minimize the risks.

Though SMPs can facilitate teaching and learning by providing opportunities for interactive discussions, sharing resources, and fostering engagement among students, the use of SMP in education also raises concerns about its potential adverse effects, such as distraction, privacy issues, and cyberbullying [15]. This research paper aims to examine the current state of social media use in engineering education, including the benefits, challenges, and potential risks associated with its use. It will also address the primary research question, "*What are the current*

trends of social media platforms usage in engineering education?" The paper uses several sub-research questions listed below to explore and classify the articles being reviewed. This study will also explore the ways in which educators can leverage social media to enhance student learning outcomes and provide recommendations for future research in this field.

RQ1: Which engineering disciplines in the articles used social media as an educational tool within the context of engineering education?
RQ2: Which types of research designs were used in the sampled articles?
RQ3: Which topics/concepts were explored in the articles on social media in the sampled articles?
RQ4: What methodologies/tools/formats were used in the articles for data collection on social media?
RQ5: What sampling methods and sample sizes were used in the sampled articles?
RQ6: Which social media platforms were used in the sampled articles?
RQ7: Which data analysis methods were used in the sampled articles?

Background and related work

Social media integration into engineering education has become a popular research topic in recent years. Social media platforms such as Facebook, Twitter, and Instagram offer a range of communication and collaboration opportunities that can facilitate learning and enhance student engagement. This literature review provides an overview of the existing research on the use of social media in engineering education, examining the benefits and challenges of incorporating social media into teaching practices.

Several studies have identified the benefits of incorporating social media in engineering education and found that the use of social media can improve student engagement and increase collaboration among students [16-18]. Similarly, [19] found that using social media in engineering courses can improve student participation, enhance the quality of discussions, and promote self-directed learning. Additionally, social media can provide a platform for students to access and share information and connect with subject matter experts [20]. Recent research has investigated the optimal way to use social media platforms as a non-formal learning environment for subjects other than STEM, such as fostering social support and building inventive literacy [21]. [22] showed that social media integration enhances the interaction between students and student and teachers, participation in creative activities, and a better comprehension of the course content. Similar to this, social media activism campaigns to increase gender diversity in the engineering field have been examined using social media applications, such as hashtags on Twitter [23]. Other benefits of incorporating social media include the adaptability of following courses at any time and in any location, as well as the optimum engagement with course materials through peer discussion and opinion exchange [24].

Despite the potential benefits of using social media, several challenges have been identified in incorporating social media into engineering education. One of the main concerns is the potential distraction that social media can cause during the class time [25]. Students may be tempted to use social media for personal reasons during class time, which could negatively impact their learning outcomes. Additionally, some students may be hesitant to participate in discussions on

social media due to concerns about privacy and security [26]. Several best practices have been proposed to address the challenges associated with using social media in engineering education. According to [8], instructors should establish clear guidelines and expectations for using social media in their courses and provide training and support to help students use social media tools effectively. Additionally, instructors should monitor social media discussions to ensure they are relevant to course objectives and address inappropriate behavior [27].

The social media learning environment

The social media learning environment is a digital space where individuals can access educational content, engage in learning activities, and connect with other learners and educators [28]. With the rise of social media platforms such as Facebook, Instagram, and Twitter, the social media learning environment has become a crucial component of modern education [29]. This is due to the widespread availability of these platforms, their accessibility through mobile phones, and their ability to connect people from all over the world.

Studies [30-33] have shown that social media can have a positive impact on learning outcomes as it provides opportunities for learners to engage in collaborative and interactive learning experiences. For example, social media platforms can be used to facilitate discussions, share resources and information, and support peer-to-peer learning. In addition, social media can also provide a platform for educators to share educational content, such as videos, podcasts, and infographics, and to connect with students in real time through live streaming and online discussions [34]. However, it is essential to note that the social media learning environment also presents some challenges. For example, it might be difficult to ensure the quality and reliability of the information and resources shared on these platforms [35]. Additionally, social media can also create distractions and reduce focus, particularly for students who are easily distracted [36]. To maximize the benefits of the social media learning environment, it is essential for educators to effectively manage and monitor the use of social media in their classrooms and to provide guidance on the responsible and effective use of these platforms for learning purposes [37]. In the following few paragraphs, we will discuss the learning environments of different social media platforms.

Facebook: Facebook is a popular social media platform used by students and teachers for educational purposes [38]. It allows users to share various materials, stay connected with loved ones, and stay informed of current events. Facebook can increase student engagement, foster collaboration, and provide access to learning resources outside of traditional classroom hours [11]. A recent study found that 94% of university students, including those in developing countries, use Facebook [39]. Students believe Facebook can be effectively used as an online learning environment [7].

Instagram: Instagram has over 800 million users, with one-third being students, making it a suitable platform for learning [40]. It offers a visually stimulating platform for sharing and discovering content, engaging students' attention, and promoting their creativity. Students can showcase their work, share ideas, and connect with professionals in their field. Instagram features live videos, stories, and hashtags, which can be used to host live events, tutorials, and discussions around specific topics or interests. Studies show that Instagram can enhance students'

learning process through visual aids, improve writing skills, aid in project reminders, and promote group work [40-42]. Overall, Instagram is a promising platform for creating a dynamic and engaging learning environment.

Twitter: Twitter's fast-paced and concise nature makes it a suitable learning environment for students. With a character limit of 280, Twitter encourages clear and effective communication, while providing access to a vast amount of information from various sources [43]. A recent study shows that architecture, engineering, and construction (AEC) university students utilize Twitter to follow subject matter experts, stay updated on relevant topics, and participate in discussions through hashtags or Tweet deck [27]. Twitter has several advantages in higher education, including access to experiential learning, rigorous discussions, and improved grades [44]. Educators are interested in exploring the practical implications of incorporating Twitter into their classrooms to establish professional learning communities, reinforce classroom concepts, and promote concise communication, which can improve critical thinking and information processing skills. Engineering students can also participate in discussions on events to enhance their learning process.

Methodology

Searching and selection procedure

The methodology for conducting a systematic literature review involves several steps to ensure rigor and comprehensiveness in the review process. The first step involves defining the research question and developing inclusion and exclusion criteria for the articles to be reviewed. This helps to narrow the focus of the review and ensure that only relevant articles are included. Next, keywords related to the research question are used to do a full search of relevant databases like Scopus, Science Direct, PubMed, Web of Science, and Google Scholar. The resulting articles are screened for duplicity and eligibility based on the inclusion criteria. The selected articles are then critically evaluated for their quality and relevance to the research questions. Finally, a synthesis of the findings from the eligible articles is conducted, and the results are organized and presented in a clear and concise manner.

In this study, the initial literature review examined a selection of studies based on specific criteria. These criteria included: (a) papers that were published within the timeframe of 2017 to 2022 and (b) papers with a social media (specifically Facebook, Instagram, and Twitter) focus on engineering. The search was conducted using the Scopus, Web of Science, Science Direct, IEEE Xplore, ERIC, and Google Scholar databases, specifically targeting articles with the terms 'Facebook AND Engineering', ' Instagram AND Engineering' and 'Twitter AND Engineering' in the article's title, abstract, or keywords. In this study, a total of 48 articles [7, 8, 16-19, 27-30, 42, 44-80] were initially reviewed for full text, and after careful consideration and evaluation, 21 of them were ultimately selected for the systematic literature review. Figure 1 shows the detailed steps followed in this research study.

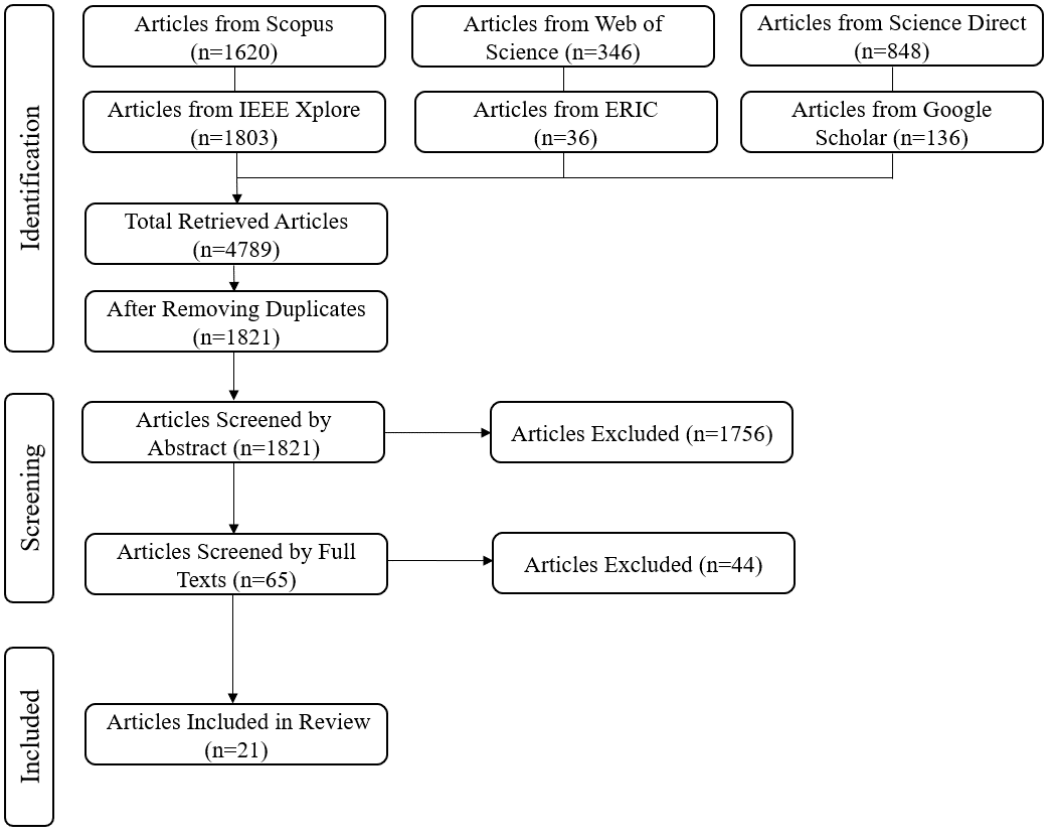

Figure 1: Framework of the study

Data Analysis

In this study, a preliminary literature review of social media in engineering education was conducted using 21 articles that were identified through a systematic search of relevant literature. All authors reviewed these articles with the specific aim of addressing the seven sub-research questions mentioned earlier. The study followed the methodology used by [81, 82] to analyze the articles based on the research questions.

Findings

We present the findings in this section of the seven sub-research questions. The data presented in this section is from the 21 articles that made it to the final synthesis phase.

RQ1: Which engineering disciplines in the articles used social media as an educational tool within the context of engineering education?

Table 1 presents information on the distribution of articles among various engineering disciplines in the sample of 21 reviewed articles. Among these, six articles (28.57%) focused on software engineering. Mechanical engineering and general first-year engineering were the subjects of 23.81% and 19.05% of the articles, respectively, while civil and electronics engineering

accounted for 14.29% each. These findings suggest that social media is relevant and applicable in diverse engineering fields, as indicated by the data in Table 1.
Table 1. Distribution of articles based on engineering discipline.

Discipline	Number	Percentage (%)
Software Engineering	6	28.57
Mechanical Engineering	5	23.81
First-Year Engineering	4	19.05
Civil Engineering	3	14.29
Electronics Engineering	3	14.29

RQ2: Which types of research designs were used in the sampled articles?

Table 2 represents the distribution of research designs employed among the sampled articles. Most of the articles (57.14%) utilized a quantitative research design, and 19.05% used a qualitative design to investigate the effect of social media usage in engineering education. A few articles (23.81%) used a mixed design that combined quantitative and qualitative methods.

Table 2. Number and percentages of articles based on research designs.

Research Design	Number	Percentage (%)
Quantitative design	12	57.14
Qualitative design	4	19.05
Mixed design	5	23.81

RQ3: Which topics/concepts were explored in the articles on social media in the sampled articles?

Table 3 displays the various topics and concepts that were examined in the sampled articles, sorted according to the different engineering disciplines. It is noteworthy that none of the topics overlapped between articles, and each article explored a unique and distinct topic.

Table 3: Topic based on engineering disciplines.

Discipline	Topics
Software Engineering	- Freshman Programming Courses - Introductory Programming - Software Design
Civil Engineering	- Flood Management - Structural Engineering Course - Construction Engineering Course
First-Year Engineering	- General Science Course
Mechanical Engineering	- Computer-Aided Design (CAD) - Mechanics of Materials

Electronics Engineering	- Energy Policy - Fundamental Electronics

RQ4: What methodologies/tools/formats were used in the articles for data collection on social media?

Table 4 displays the various data collection methods or formats used in different articles. Table 4 also shows the frequency and percentages of each type of data collection method used in the sampled articles. The results show that questionnaires were the most common way to collect data in quantitative and qualitative research designs (57.14%, or 12 articles). The second most utilized data collection format in quantitative research studies was feedback, at nearly 14.28%. Questionnaires were also the most frequently used data collection approach (9.52%) in mixed-design studies. However, one study used only an analytical approach.

Table 4: Data collection method, frequency, and percentages

Research Design	Data Collection Method	Frequency	Percentage (%)
Quantitative design	- Questionnaire	9	42.86
	- Feedback	3	14.28
Qualitative design	- Questionnaire	4	19.04
Mixed design	- Questionnaire	2	9.52
	- Focus groups	2	9.52
	- Analytical	1	4.76

RQ5: What sampling methods and sample sizes were used in the sampled articles?

Table 5 displays the various sampling techniques employed in the sampled articles. Most of the articles (66.67%) employed random sampling to select their study participants from the population. This high percentage of random sampling may be because many studies used students from their classes as their study participants. Only four studies (19.05%) used a convenience sampling technique, while three articles (14.29%) did not indicate the sampling method used in the study. Table 6 presents the frequency, percentage, and range of sample sizes used in the sampled articles. Of the articles examined, eight (38.10%) employed sample sizes ranging from 15 to 100, seven articles (33.33%) used sample sizes ranging from 100 to 200, and five articles (23.81%) used sample sizes equal to or greater than 200.

Table 5: Sampling methods

Sampling Methods	Frequency	Percentage (%)
Random sampling	14	66.67
Convenience sampling	4	19.05
Did not mention	3	14.29

Table 6: Samples sizes

Sample Size	Frequency	Percentage (%)

15-100	8	38.10
100-200	7	33.33
200 and more	5	23.81
Not applicable	1	4.76

RQ6: Which social media platforms were used in the sampled articles?

Table 7 shows the different social media platforms used in engineering in the sampled articles. Most of the studies (12 articles) used Facebook as their social media platform, indicating the popularity of this platform. 23.81% (5 articles) of the articles used two or more platforms, while none of the articles used Instagram as the sole communication medium. Among those five articles, one study used Facebook and Instagram, one study used Facebook and Twitter together, and another study used Facebook and WhatsApp together. Two articles considered YouTube, along with Twitter, Facebook, Instagram, and WhatsApp, as a learning environment. Twitter is the second most sole popular social media platform, followed by Facebook.

Table 7: Social Media Platforms

Social Media Platform	**Frequency**	**Percentage (%)**
Facebook	12	57.14
Twitter	4	19.05
Instagram	0	00.00
Combined	5	23.81

RQ7: Which data analysis methods were used in the sampled articles?

Table 8 provides information on the data analysis methods utilized in the articles that were examined in this study, along with the frequencies and percentages of their use. The research articles that employed descriptive analyses as their research methods primarily utilized means, variance, and graphs (66.67%) as their data analysis methods. Among inferential analysis methods, ANOVA (23.81%) and t-tests (23.81%) were the most used data collection methods. Additionally, some articles also utilized regressions (14.28%) as their data analysis methods to find the correlation among different factors. Descriptive analysis and content analysis were the data analysis methods most frequently used in qualitative analysis research methods.

Table 8: Data analysis methods

Research Methods	**Data Analysis Methods**	**Frequency**	**Percentage (%)**
Descriptive analysis	- Means	14	66.67
	- Variance	14	
	- Graphs	14	
Inferential analysis	- ANOVA	5	23.81
	- T-test	5	23.81
	- Regressions	3	14.28

Qualitative analysis	-	Content Analysis	2	9.52

Discussion

The aim of this study was to conduct a preliminary review of the literature on social media in engineering education, covering articles published between 2017 and 2022. Seven research questions were investigated, with the first question focusing on the engineering disciplines that used social media in engineering education. The results indicated that the top three engineering disciplines that used social media were software engineering, general engineering, and mechanical engineering. The second research question determined the different research designs used in social media in engineering education. Most articles (61.90%) used quantitative methods as their preferred research design.

The study revealed that there was no overlap in the topics covered by the articles, and they explored a unique and distinct topic. There is an opportunity for future research to conduct analogous studies within the same topic or field. Multiple research studies on the same topic or field are crucial for several reasons. First, it helps to establish the validity and reliability of the findings. When different studies consistently report similar results, it increases confidence in the accuracy and generalizability of the findings. It also helps to identify any discrepancies or inconsistencies in the results, which can lead to further investigations to reconcile the differences. Second, multiple studies on the same topic allow for a more comprehensive understanding of the phenomenon under investigation. Each study may focus on different aspects or variables, and together they provide a holistic picture of the research topic. This can lead to the development of more nuanced and sophisticated theories or models. Third, conducting multiple studies can help identify gaps in the existing research and areas in need of further investigation. New studies may be designed to address these gaps, leading to new discoveries or applications.

Facebook was found to be a good learning environment by most research articles due to various reasons. First, it is the most popular social media platform that provides opportunities for students to connect and collaborate with others from different locations. It offers features such as private groups, pages, and discussions that promote academic communication, information sharing, and resource utilization. Second, Facebook's accessibility and familiarity make it easy for educators to integrate into their teaching practices, enhancing student engagement and participation. Its social nature also encourages peer-to-peer learning and collaboration, allowing students to support each other and share their knowledge and experiences. Lastly, Facebook serves as a platform for teachers to post announcements, reminders, and assignments, keeping students informed and up to date on their coursework. It also enables teachers to engage with their students outside of the classroom, answer questions, and provide feedback on student work.

The data analysis of the reviewed articles demonstrates the importance of network data analysis in the social media learning environment. More research is needed in this space that uses network data analysis to obtain detailed insights from participants' interaction data, as this approach can provide a deeper understanding of the complex dynamics of social media interactions [76]. Network data analysis involves the use of mathematical and computational tools to analyze social networks, such as the patterns of connections, communication flows, and

information sharing among users. By applying network data analysis to social media platforms, researchers can obtain detailed insights into how users engage with each other, what topics they discuss, how they share information, and how their interactions influence their learning outcomes. Network data analysis can also help researchers to identify and analyze different types of social networks and their characteristics, such as the formation of cliques, the influence of key players, and the presence of sub-groups or communities. These insights can be used to design and implement effective interventions, such as social network interventions, that can enhance learning outcomes, increase engagement, and promote collaboration among students.

The use of social media in engineering education has the potential to enhance student engagement, promote collaboration, and provide access to a wide range of resources [34]. However, it is important to address the challenges associated with social media use, including potential distractions and privacy concerns. By establishing clear guidelines and best practices for social media use, instructors can effectively incorporate social media into their teaching practices and improve the overall learning experience for students. Based on the articles reviewed, several limitations of social media platforms caught our attention, and the same are mentioned below:

Limited control over content: While social media provides access to a wealth of resources, it also presents a challenge in terms of controlling the content that students can access. This can lead to distractions, as students may be exposed to inappropriate or irrelevant information while using the platform for educational purposes.

Privacy concerns: The use of social media as a learning environment can also raise concerns about privacy. The platform requires users to provide personal information, which can be used for targeted advertising and other purposes. This can be a concern for students, who may not want to share personal information with their peers or teachers.

Technical limitations: Technical limitations, such as slow connectivity and unreliable service, can also hinder the effectiveness of social media as a learning environment. This can lead to frustration and decreased engagement among students and teachers.

Impact on student engagement and learning outcomes: Studies have shown that the use of social media as a learning environment can have a positive impact on student engagement and learning outcomes. For example, a study by [29] found that students who used social media as a learning environment reported higher levels of engagement and satisfaction with their courses compared to those who did not use the platform. In addition, research by [38]found that students who used Facebook as a learning environment scored higher on assessments compared to those who did not use the platform.

Conclusions, limitations, and future work

In conclusion, the use of social media as a learning environment has the potential to enhance student engagement, improve access to resources, and facilitate communication among students and teachers. Research has shown that the use of social media as a learning environment can have a positive impact on student engagement and learning outcomes. This study provides a

preliminary overview of the research on the use of social media in engineering education. The findings indicate that Facebook, Instagram, and Twitter have been used in a few engineering disciplines, including software engineering, civil engineering, mechanical engineering, and electronics engineering. More than half of the sampled articles used quantitative research designs, descriptive statistics for data analysis, and Facebook as their preferred social media.

Like other research studies, this study also comes with some limitations. First, this study focused only on three social media platforms: Facebook, Instagram, and Twitter, while other social media platforms, including WhatsApp, Reddit, YouTube, LinkedIn, TikTok and WeChat that might have significant implications for engineering education. Future research may investigate other social media platforms, their usage, and their impact on engineering student engagement and learning. Second, the search terms included in this study were 'Facebook AND Engineering', ' Instagram AND Engineering' and 'Twitter AND Engineering'; hence the articles retrieved from different databases using these search terms may have biased our analysis by focusing on just these three platforms. In addition to these search terms, others could be included, for example, ' social media AND engineering'; this would have further broadened our search canvas. Third, this study reviewed only articles published from 2017 to 2022, which is another limitation as this study might have missed some important articles published before 2017, which could have provided some more critical insights into this study. A potential direction for future research would be exploring the use of all social media platforms in engineering and its impact on student learning.

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