Bridging the Gap: The Impact of Social Media on Modern Engineering Education—A Systematic Literature Review

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She gained expertise in the controlled synthesis and biochemical characterization of complex protein nanocomposites. In her teaching, she has been dedicated to engaging students in an interactive learning environment, and she is strongly committed to promoting diversity, equity, and inclusion. As a visiting assistant professor at the University of Oklahoma, Dr. Rouf has received NIH funded grant and she continues to build on her previous training in biopolymers and nanoparticles by moving into a biological system that will allow her to address additional questions regarding the utilization of nanomaterials in cancer diagnosis and drug delivery. Through her teaching, research, and outreach activities Dr. Rouf's is interested in making long-term impacts in cutting-edge research and engineering education.

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Abstract

People can share information, ideas, and opinions on various topics through social media, an interactive platform that facilitates communication. In education, it has been demonstrated that social media increases student participation, engagement, and learning. As such, it is becoming more widely acknowledged and accepted in engineering education. This theory paper analyzes the various research studies done in the field by summarizing the research topics, elements of social media used, and analysis techniques, among other things. The goal is to propose implications for researchers and practitioners for the effective use of social media platforms in engineering education. The primary research question is "What are the themes, practice, and research implications emerging from the research on the use of social media in engineering education?"

To answer this research question, a systematic literature review (SLR) was conducted. The SLR consists of three parts: identification, screening, and synthesis. In the identification phase search terms were used to retrieve articles from several databases including Scopus, Science Direct, Web of Science, Wiley Online Library, ERIC, IEEE Xplore Library, and Google Scholar. To find articles from these databases for this literature search, the search terms Facebook + Engineering, Instagram + Engineering, and Twitter + Engineering were used. A total of 1821 articles were retrieved. They were then screened by abstract and full texts, cutting it down to 16 articles that made it to the final review and synthesis phase. The screening was done throughout these phases using the 5 exclusion criteria (EC). EC1: articles published before 2017, EC2: articles not focused on engineering, EC3: articles in languages other than English, EC4: articles with a focus other than Facebook, Instagram, and Twitter, and EC5: work-in-progress articles. The synthesis of these articles revealed four themes, Active Learning and Engagement Through Social Media, Social Media Information Literacy, Social Media as an Online Education Tool, and Improving Education with Social Media Analysis. The paper discusses findings regarding each theme and the implications these findings have for practice and research.

Introduction

Social media, with its ability to connect people globally and share information interactively, is becoming increasingly recognized as a powerful tool in various fields, including education. In the realm of engineering education, the potential role of social media is becoming widely recognized due to its ability to enhance student participation, engagement, and the overall learning experience [1]. The rapid evolution of social media platforms like Facebook, Instagram, and Twitter, initially created primarily as social networking sites, has made them viable platforms for educational purposes, reshaping how information is disseminated and consumed in academic settings. Please note, in this study, we are not referring to Twitter as “X” intentionally, as when we first started working on this article, Twitter had not been renamed and all sited sources predate Twitter’s name change to “X”.

Recent studies in engineering education suggest a shift. Traditional teaching methodologies are being supplemented, if not replaced, by more interactive and student-centered approaches facilitated by social media [2]. This shift is indicative of broader changes in educational strategies, where the focus of instructors is now on active learning and student engagement [3-4]. Social

media's role in this transition is critical, as it provides students with a platform for more dynamic interaction and engagement, which is essential in fostering a productive learning environment.

Furthermore, the integration of social media into engineering education aligns with current trends toward more personalized and technology-enhanced learning experiences. The use of platforms like Twitter, Facebook, and Instagram in educational contexts has been linked to improved student engagement and participation, offering innovative ways to present content and facilitate interaction among students, and between students and instructors [5-6].

This paper aims to systematically review the literature in the field, analyzing various research studies on the use of social media in engineering education. The study focuses on summarizing the research topics, elements of social media used, and analysis techniques employed in these studies. The paper intends to synthesize findings and establish implications for researchers and practitioners. It will answer the primary research question: " What are the themes, practice, and research implications emerging from the research on the use of social media in engineering education?" Integrating social media into engineering education is a significant step toward creating more engaging, interactive, and effective learning environments. This paper seeks to contribute to the ongoing discourse in this area. Educators and institutions can use the insights and implications provided to harness the full potential of social media in engineering education.

Methods

The systematic literature review (SLR) began with inputting three search terms Facebook + Engineering, Instagram + Engineering, and Twitter + Engineering in several databases including Scopus, Science Direct, Web of Science, Wiley Online Library, ERIC, IEEE Xplore Library, and Google Scholar. The complete step-by-step process of the SLR is shown in Fig 1. After removing duplicates, 1821 articles were retrieved from six databases using three search terms. These articles were screened using the 5 exclusion criteria (EC). EC1: articles published before 2017, EC2: articles not focused on engineering, EC3: articles in languages other than English, EC4: articles with a focus other than Facebook, Instagram, and Twitter, and EC5: work-in-progress articles [7]. The articles published before 2017 were purposefully excluded from our analysis to focus our research on the most recent trends surrounding the research topic. Also, when we first limited the scope of our search to 2013–2022, we found many articles, which made it nearly impossible to finish the review process. As seen from Fig 1, 1821 articles were screened by abstract, and 1756 were excluded as they met one of the exclusion criteria. The remaining 65 articles were screened by full text and 46 articles were removed from the study. Only 16 articles made it to the final review and synthesis phase of the SLR process.

The 16 articles were reviewed in detail to extract information such as engineering disciplines focused on in the sampled articles, types of research design, topics/concepts explored, methodologies/tools/formats used, sampling methods and sample sizes, social media platforms, and data analysis methods. The preliminary findings from this study were published in 2023 [7], and in this study, we focus on the thematic analysis of the information retrieved from the review of 16 articles.

The final 16 papers were reviewed in detail and information from each of those 16 articles including the year of publication, title, research question, research methodology, data collected, sample and sample size, data analysis techniques, findings, conclusions, etc. were stored in an

Excel file. This information was further reviewed and coded. The coding was done in three steps (1) each article was assigned several codes in the first phase, (2) the codes were reviewed to ensure they aligned with the research question and redundant codes were removed, and (3) codes that would make sense to combine were combined to form categories/themes. Four themes emerged from the data analysis. In the next section, we present the themes in detail.

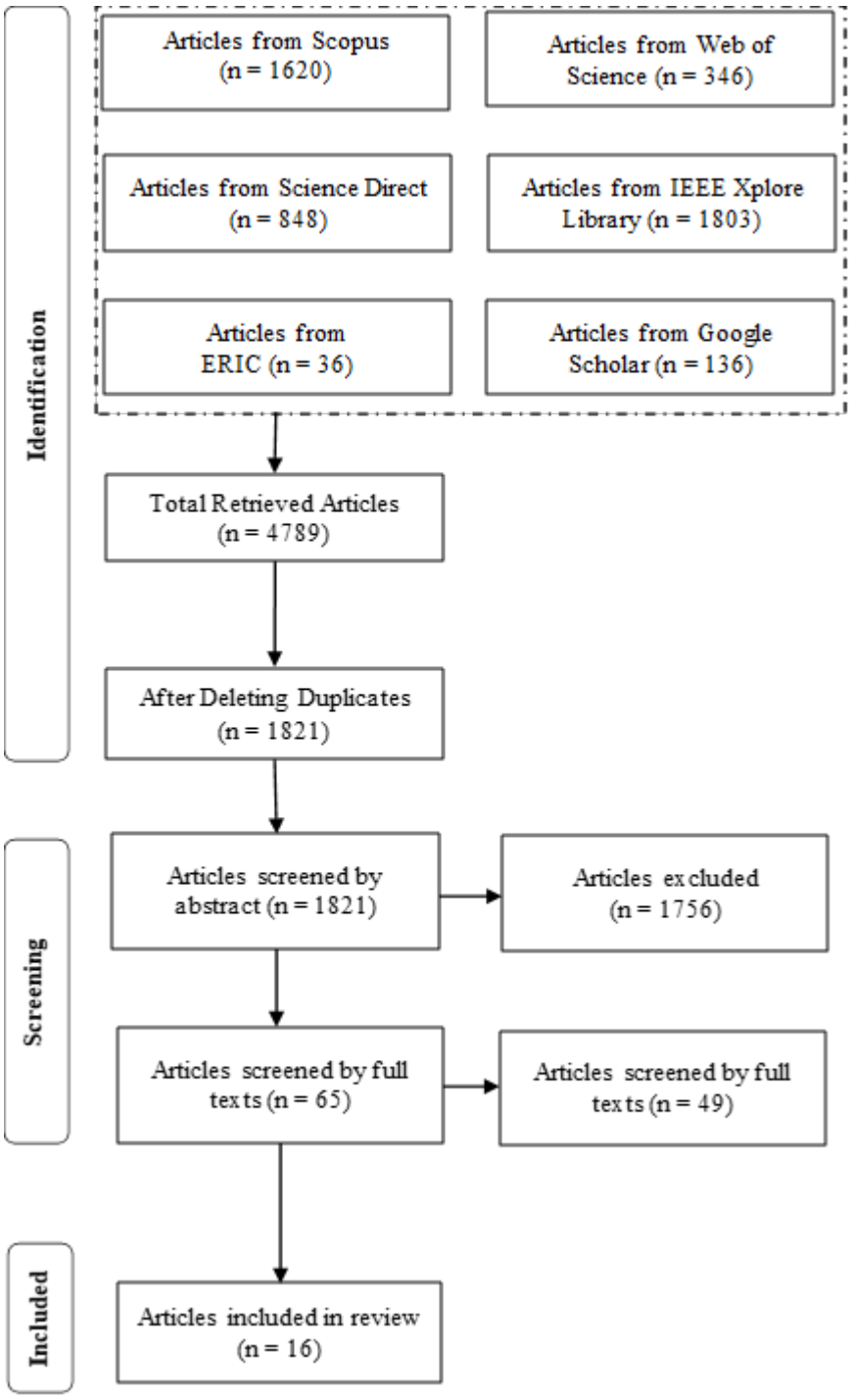

Fig 1. Systematic Literature Review Article Selection Process using PRISMA

Findings

Preliminary Findings

Some of the preliminary findings from our work [7] are summarized in this paragraph. The findings indicated that the social media platforms Facebook, Instagram, and Twitter were used in research studies that catered to several engineering disciplines including electronics engineering, software engineering, civil engineering, and mechanical engineering. Facebook was the favored social media platform, descriptive statistics were utilized for data analysis, and quantitative research designs were employed in over half of the sampled articles.

Themes

After a review of the 16 articles, fifteen codes were assigned including engagement, collaboration, communication, source of information, research, access, convenience, pedagogical, academic performance, distance learning, analysis, research, classification, and insight. Table 1 shows how these codes were organized under each theme and a description of each. Some articles fall under multiple themes. The themes presented in this section begin with a detailed description of the theme, explaining two exemplar studies that closely relate to the theme, research, and practice implications grounded in the theme (this format/structure of presenting the themes was derived from [8]).

Table 1. Sampled articles according to theme.

Theme	Definition	Codes	N
Active learning and engagement through social media	Topics describing social media's impact on communication, both between students and from students to professors. This dynamic interaction is widely recognized as a significant benefit to education, contributing to enhanced academic outcomes for students.	Engagement Collaboration Communication	6
Social media information literacy	Topics that discuss social media as a convenient place for students to access information. They emphasize the accessibility and user-friendly nature of social media, which make them excellent resources for students seeking information.	Source of information Research Access Convenience	4
Social media as an online education tool	Topics that show the educational benefits linked to the incorporation of social networking sites into teaching methods provide insights into their ability to improve teaching strategies for educators.	Pedagogical Academic Performance Distance Learning	6
Improving education with social media analysis	Topics describing the use of social media by educators and experts to understand student perspectives, gaining valuable feedback on student successes and challenges.	Analysis Research Classification Insight	3

Theme 1: Active learning and engagement through social media

Several studies have explored the influence of social media in the educational landscape, with a focus on its role in easing effective communication and fostering collaboration among students. These platforms, particularly ones like Facebook, Instagram, and Twitter are increasingly being recognized by students for their potential in improving the learning process. This recognition is not only about the accessibility or ease of use of these platforms but also about the social dynamics they foster. These attributes encourage their application for educational purposes. Six articles highlight a common theme of the impact of social media on active learning and engagement. These articles emphasize how the integration of social media into educational contexts not only improves student involvement but also contributes positively to academic performance and promotes stronger interpersonal connections among peers. These studies [9-14], emphasize the role social media platforms play in enhancing educational communication, offering insights into the reasons behind positive academic outcomes among university students. The studies suggest a correlation between academic success and the strategic, purposeful use of social media for communication in educational settings. Such usage goes beyond casual or social interactions, tapping into the platforms' capabilities for facilitating discussions and creating an interactive learning environment.

Exemplar Study 1

The studies chosen under this theme show how social media has helped engineering students succeed in their studies while addressing doubts that social media does greater harm to student grades than it helps. For example, the study by Goh explores the use of Facebook for educational communication and its resulting impact on students perceived academic achievement [11]. This research, performed at a large technology and engineering university in Malaysia, used a methodological approach involving a self-administered questionnaire distributed among students who are active Facebook users. The analytical framework adopted for this study was the Partial Least Squares Path Modeling. The key findings of this research indicates that the use of Facebook for educational purposes is significantly influenced by subjective norms, which refer to the social influence exerted by peers and the academic community, and purposive values, indicating the goal-directed use of the platform. Notably, the study underscores that leveraging Facebook for educational engagement is positively associated with student's perception of their academic success. This correlation suggests that the integration of social media platforms like Facebook into the realm of higher education may offer tangible benefits [11]. The study proposes that the combination of social influence and goal-oriented motivations drives students to utilize Facebook for educational communication. This usage pattern is positively linked to their perceived academic achievement, highlighting the potential of social media as a beneficial tool in educational settings, especially in facilitating active learning and engagement.

Exemplar Study 2

Eneje (2020) investigated the engagement of engineering students in virtual learning environments, specifically focusing on two social networks: a blog and Facebook. The study used a quantitative approach and was conducted over six weeks, from 26th August to 6th October 2019. It involved 76 students and the instructor analyzing the interactions on these two platforms. The data collection involved recording the magnitude of posts, comments, and reactions on both the blog and Facebook [10]. These interactions were manually entered into spreadsheets to build datasets for each site. The Social Network Analysis tool was used to analyze these datasets, focusing on the network traffic of the two sites. The analysis included generating network plots and metrics, such

as network density and centrality measures, to understand the patterns of student interaction and engagement. The findings indicated that there was more engagement on Facebook compared to the blog. This was evidenced by the higher network density on Facebook, implying stronger cohesion among participants. The study also found that the presence of non-class members in the Facebook group enhanced the emergence of more edges in the network structure, suggesting that popular social network sites create more links and attract more interaction. The results suggested that the choice of social network significantly influences the level and nature of student engagement in virtual learning environments [10].

Research Implications

Social media plays a multifaceted role in the academic and social lives of students, especially in STEM and engineering contexts. Research indicates that social media serves as an effective educational tool by enhancing engagement, communication, and collaborative learning. It is important to understand the intricate dynamics of social networks in learning environments to properly balance the use of social media in educational settings [11]. Researchers specifically cited Facebook as a valuable source that positively impacts academic success in educational communication [11] Facebook education disrupts the conventional, passive, and rigid educational model that traditionally discourages and alienates students from classrooms [13]. Facebook does this by encouraging communication, participation, and teamwork among students generating interest and motivation. This leads to greater academic success among students [13]. Yet, researchers also highlight potential drawbacks. These include distractions and negative impacts on mental health and academic performance due to extreme social media use [9]. While social media can be leveraged as an effective educational tool, the nature and extent of its impact on learning outcomes and student engagement is nuanced and situationally dependent. These implications are crucial for educational researchers in developing strategies to integrate social media effectively into learning processes. Further research must be done to find ways to ensure that these platforms are used in a way that enhances, rather than detracts from, positive educational experiences.

Practice Implications

Social media has been found to not directly correlate with poor academic performance and suggests that outright restrictions on social media may not be necessary. Instead, the focus should shift to guiding students on how to use social media platforms effectively [11]. Specifically, educators and institutions should harness social media platforms as tools for enhancing educational communication and engagement, potentially improving academic outcomes [10]. For instance, creating structured academic groups or forums on social media can facilitate information exchange, discussion, and collaboration among students. In developing countries, many educators don't have access to traditional online teaching tools through their institutions. Social media has proven an effective platform for them. Educators can successfully use social media that already has a strong student presence instead of dedicated course management platforms [12]. Overall, a balanced and informed approach towards social media in educational settings is necessary, where these platforms are neither vilified nor unrestrictedly endorsed but strategically utilized to enhance the learning experience.

Theme 2: Social media information literacy

In this theme, four studies emphasize the significance of Social Networking Sites (SNSs) as reference sources for students. These studies highlight the accessibility and user-friendly nature of

SNSs, making them valuable platforms for information retrieval by students. Three of these articles [15-17] draw attention to how SNSs can serve as efficient resources for accessing course materials, notes, and timely announcements. This accessibility is particularly beneficial for engineering students, enhancing their prospects for success in their academic endeavors. The provision of accurate and up-to-date information via SNSs extends support to students beyond scheduled tutorial sessions. Additionally, one of the articles [18] explores the role of social networking sites in attracting and retaining students. It highlights the value of SNSs in delivering easily accessible information about courses and coursework, contributing to success in student enrollment and retention.

Exemplar Study 1

Tinmaz and Lee (2021), explored the integration of a closed Facebook group into a computer programming course in three engineering departments at a Turkish private university [16]. It involved 240 students using the Facebook group as a Learning Management System. The research utilized a survey comprising demographic questions, opinion-based queries on Facebook group use, and 32 perception-related questions regarding Facebook in education, answered on a 5-point Likert scale. The results revealed that most students preferred using the Facebook group for accessing shared lecture notes and staying informed about course-related issues. The group was maintained as a secret with clear rules, which was deemed crucial by the students. The study found that the Facebook group neither distracted students nor appeared uninteresting to them. The research further suggested that Facebook can be an effective educational tool, particularly for facilitating access to course materials, and updates, and enhancing student communication and cooperation [16]. This positive reception of the Facebook group among students challenges the conventional view that social media platforms are unsuitable for academic purposes, indicating a potential shift in the perception and use of educational tools.

Exemplar Study 2

This exemplar study highlights how students can use social media to obtain accurate information and discern relevant content from faculty. This study by Vega (2021) focuses on the use of social media as a communication channel during the COVID-19 pandemic within the faculty of industrial engineering [17]. The study targeted undergraduate students on the main campus, aiming to understand how they obtained accurate and timely information and to identify the content relevant to their needs. To conduct this research, social media data metrics were collected, and a focus group session was held. The results indicated that students predominantly used Instagram as their primary source of information from the faculty. They sought clear, accurate, timely, and immediate information, primarily about processes they could undertake during the semester to meet the course objectives and avoid setbacks. The focus group revealed that students preferred Instagram due to its ease of access via mobile phones, the simplicity of interactions, and the direct delivery of information to their news sections. The research concluded that Instagram played a significant role in providing students with essential information during the pandemic. The findings emphasize the importance of selecting suitable communication platforms to meet students' needs and expectations in higher education, particularly in emergencies like the COVID-19 pandemic [17].

Research Implications

Social media is rapidly evolving in educational contexts. Educational institutions have changed their perceptions regarding the use of social media and are choosing to utilize it more. The

accessibility and user-friendliness of these platforms make them essential tools for information dissemination and retrieval [17]. Platforms such as Facebook, Twitter, and Instagram all have been found to impact the learning process positively. Social media fosters knowledge sharing and allows for easier access to information [15]. These studies contribute to the broader understanding of digital communication tools in academia, demonstrating that platforms traditionally viewed as purely social can effectively support educational objectives. This research suggests a need to reassess traditional views of social media in education and to further research how social media platforms can be tailored to enhance learning experiences and information dissemination in various academic disciplines.

Practice Implications

Integrating social media platforms like Facebook into formal education settings can be beneficial for distributing course materials and facilitating student communication [16]. Vega's findings reinforce this, showing that platforms like Instagram can serve as effective channels for circulating important information rapidly and accessibly [17]. Research indicates that educational institutions should consider incorporating social media more strategically into their communication and teaching methodologies. Not only can this enhance student engagement and access to information, but it can also provide a more flexible and responsive educational environment. Consequently, educators and administrators should be encouraged to develop clear guidelines and strategies for utilizing these platforms to maximize their educational potential while addressing concerns like distraction and misinformation.

Theme 3: Social media as an online education tool

In the context of the theme, six distinct articles have directly examined the educational advantages associated with the integration of social networking sites into instructional practices, shedding light on their potential to enhance pedagogical approaches for instructors. Four out of these six articles have reported evidence in support of social networking sites, demonstrating their positive impact on students' academic performance and their ability to enhance the overall learning experience [11], [15], [19]. This effect is particularly pronounced when dealing with intricate subjects like engineering disciplines, where social media emerges as a valuable and versatile teaching tool. Additionally, two articles specifically highlight social media as a standalone platform tailored for use within the realm of engineering education [13], [20]. Especially during unprecedented circumstances such as the COVID-19 Pandemic, social media has proven itself to be a successful and indispensable medium for educators to effectively deliver remote instruction to their students. However, caution is advised. One article stresses that despite the convenience offered by SNSs in engineering education, these platforms may become distractions if not used purposefully [21]. It emphasizes the importance of staying focused on the primary goal of incorporating SNSs into academic activities, avoiding unintended diversions. When integrated thoughtfully, social media proves to be a powerful tool, enhancing students' academic performance by leveraging its inherent advantages [21].

Exemplar Study 1

The exemplar studies under this theme were chosen as they explicitly center around improvement in the academic success of students after social media was implemented in their learning. One of the studies aimed at assessing the impact of social media learning environments on the learning process of Architecture, Engineering, and Construction (AEC) courses [15]. Gambo, Musonda,

and Zadawa created a quantitative study that involved a structured questionnaire survey distributed to 600 AEC university students. The methodology included a stratified proportionate random sampling of the students across various AEC courses and academic levels, with 315 questionnaires being analyzed. The analysis utilized Partial Least Squares-Structural Equation Modeling (PLS-SEM) with the WarpPLS 7.0 tool, chosen for its predictive ability and efficacy in examining causal relationships between variables. The results of the study revealed a positive correlation between social media learning environments and the AEC learning process. Specifically, the YouTube learning environment was found to have a significant positive impact on the AEC learning process, while platforms like Facebook, Twitter, and Instagram showed moderate effects. This study's findings suggest the utility of integrating social media learning environments in AEC courses, especially in other developing countries facing similar educational challenges in AEC fields [15].

Exemplar Study 2

In another study, Paragulla and his associates [13] investigated the effectiveness of Facebook as a teaching tool in programming courses. The methodology involved a survey-based study that compared the impact of using Facebook as a didactic tool versus traditional teaching methods on students' interest, motivation, and perception of collaborative learning. The results indicated a significant positive impact of using Facebook in teaching. Specifically, 85% of students reported improved interest in courses, 78% reported improved motivation in the teaching-learning process, and 95% valued collaborative learning using Facebook. Moreover, 96% of students believed that using Facebook positively influenced their teaching-learning process. These findings suggest that integrating Facebook into the teaching strategy enhances student engagement and collaboration, making the learning process more dynamic and effective. The study concludes that using Facebook as a teaching tool significantly benefits the learning experience in programming courses [13].

Research Implications

There is a mixed perception among students and educators about social media and its use. Further research must be done regarding the factors that determine whether social media is perceived as beneficial or detrimental, such as types of social media usage, individual learning styles, and the specific academic context. Studies have found positive correlations between social media integration and student engagement, motivation, and collaborative learning [13]. Social media platforms like WhatsApp and Instagram, when used appropriately, can positively impact students' academic performance [19]. These outcomes encourage future research to delve into the specific features of social media platforms that foster these positive educational experiences, and how these can be harnessed effectively across various educational settings and disciplines. There is a need for a more nuanced understanding of the role of social media in education, encouraging further exploration into its pedagogical integration and its varied effects on different student demographics.

Practice Implications

While students recognize the potential benefits of social media in academics, there is also an acknowledgment of its distracting aspects [15]. Educators and institutions should guide students on the effective and balanced use of social media for academic purposes. Workshops or modules on digital literacy that include strategies for leveraging social media in learning while managing its potential drawbacks could be beneficial. Online distance learning is feasible and effective across various fields, including engineering [20]. Studies further support the integration of social media tools into the curriculum [13]. This could involve the creation of educational groups or

forums on platforms like Facebook for discussion, peer-to-peer learning, and the dissemination of course-related materials, thus making learning more interactive and accessible. Studies emphasize the importance of adapting to digital trends in education and suggest that educators should be open to integrating social media into their teaching methodologies while also being aware of its limitations and potential challenges.

Theme 4: Improving education with social media analysis

In the exploration of this theme, three articles have utilized social media as a tool to analyze the experiences of engineering students during their educational journey. These articles, cited as [22-24], investigate how students can leverage social media to express both their challenges and achievements in learning environments. The analysis of these insights can be used to improve students' learning experiences overall. Specifically, two of these articles [22-23], delve into the use of this analysis to gain firsthand accounts of engineering students' experiences within their programs, fostering a deeper understanding of the dynamics of engineering education. One article [24], further touches upon this aspect and also elaborates on how social media insights can raise awareness of engineering. This, in turn, promotes greater accessibility to underrepresented demographics in the field of engineering and can encourage students to pursue or embark on their engineering education journey.

Exemplar Study 1

The exemplar studies under the theme of improving education with the use of social media analysis were chosen to emphasize how the use of social media allows for greater insights into student experience and to increase interest in the study of engineering. A study by Abdelhamid et al., (2020) focused on analyzing tweets to gain insights into the experiences of first-year engineering students [22]. Abdelhamid, Aly, and Katz (2020) developed an automated software pipeline to collect tweets using the Twitter API, focusing on keywords related to first-year engineering experiences. The data collection spanned from 2016 to 2019, resulting in a dataset of 10,000 tweets. This process included harvesting, archiving, and analyzing the tweets. The analysis comprised both quantitative and qualitative methods, including descriptive data analysis, codebook analysis, sentiment analysis, and network analysis. The results revealed significant insights into the first-year experiences of engineering students. Descriptive analysis showed the distribution and patterns of tweets over time, the most active accounts, and the use of URLs in the tweets. Codebook analysis identified key themes and topics in the tweets, while sentiment analysis provided an understanding of the emotions and opinions expressed. Network analysis elucidated the social connections and interactions among the users. The research concluded that Twitter is a valuable source of information to understand various aspects of engineering education, particularly the first-year experience. The study also introduced a web-based chatbot for accessing the latest tweets, news feeds, and the harvested tweet dataset, enhancing the utility of the research for other scholars and students [22].

Exemplar Study 2

In another study, Malik and his team explored Twitter engagement during National Engineers Week [24]. The study used a mixed-method approach, analyzing 6,583 original tweets and 10,885 retweets associated with the campaign's hashtags "#eweek2017" and "#engineersweek." Their key findings indicate that engineering companies and individuals were the primary participants, with minimal involvement from educational and professional engineering bodies. Tweets mainly

focused on event promotion, showcasing engineering professionals, and engaging the public, especially women and children, in engineering. The analysis highlighted the role of influential entities in spreading information. The study concluded that social media, specifically Twitter, can significantly enhance community engagement in educational and promotional events. However, it also highlighted the need for strategic use of hashtags and media elements to maximize outreach. The research provides valuable insights into how Twitter can be used effectively to foster community engagement, especially in the context of STEM education and promotion [24].

Practice Implications

Within the domain of social media analytics, there are broad and valuable applications within engineering education. Using Twitter data to understand first-year engineering students' experiences emphasizes the potential of social media as a rich, real-time data source for educational research [22]. It emphasizes the need for more studies that use social media data to uncover student experiences and sentiments in various educational situations. Twitter proves to be an effective way of examining online community engagement in STEM fields [24]. Further work must be done to search more efficiently to get the most useful information possible. Analysis of social media commentary opens avenues for future research to explore the dynamics of how social media campaigns can effectively promote STEM education and careers, particularly in terms of engagement strategies and content optimization.

Research Implications

Improvement of engagement and communication strategies in educational settings allows for greater success for both the students and the educator. The analysis of students' tweets and other social media information [22] can inform educators and institutions about the real-time concerns and experiences of new students, guiding the development of targeted support systems, curriculum design, and student engagement strategies. For instance, understanding the prevalent themes in students' social media discussions can help create more relevant and supportive educational environments. Learning from social media insights provides critical information for organizers of educational campaigns and events in STEM [24]. They demonstrate the effectiveness of social media in reaching and engaging diverse audiences, underscoring the need for strategic use of hashtags, media elements, and influential participants to maximize the impact of such campaigns. These findings can be applied to enhance the planning and execution of future STEM promotion initiatives, ensuring wider and more effective public engagement.

Conclusions and Future Work

This systematic literature review meticulously examines the use of social media in engineering education, revealing themes, practice, and research implications that shape the current and future landscape of this field. Our comprehensive approach addresses the primary research question, " What are the themes, practice, and research implications emerging from the research on the use of social media in engineering education?"

The findings reveal four distinct themes, each contributing uniquely to understanding the role of social media in engineering education:

1. Active learning and engagement through social media: Studies indicate social media platforms like Facebook, Instagram, and Twitter significantly enhance student engagement, collaboration, and communication, contributing to improved academic outcomes.
2. Social media information literacy: social media serves as an efficient, accessible, and user-friendly source for course materials and timely announcements, proving particularly beneficial in distance learning and during emergencies like the COVID-19 pandemic.
3. Social media as an online education tool: The integration of social networking sites into pedagogical practices has been shown to positively influence students' academic performance, especially in complex subjects like engineering.
4. Improving education with social media analysis: Insights from social media analysis have been instrumental in understanding student perspectives and experiences, aiding in the enhancement of educational strategies and content delivery.

The literature underscores social media's transformative role in engineering education, marking a shift from traditional pedagogies to more interactive, student-centered approaches. This integration aligns with contemporary trends toward personalized, technology-enhanced learning experiences.

However, this study has limitations. It focuses only on three social media platforms - Facebook, Instagram, and Twitter - neglecting others like WhatsApp, Reddit, YouTube, LinkedIn, and TikTok, which might also significantly influence engineering education. Additionally, the use of specific search terms might have biased our analysis towards these three platforms. Future research should expand to include a broader range of social media platforms and search terms, like 'social media AND engineering', to widen the research scope. Moreover, limiting the review to articles published from 2017 to 2022 may have caused us to miss critical insights from earlier works. Future studies should explore a broader timeframe and a more diverse range of social media platforms to fully comprehend their impact on engineering education.

Our research contributes actionable insights and implications for educators and institutions, advocating for a balanced and informed approach to incorporating social media into educational settings. Future research should investigate the nuanced impacts of these platforms on different student demographics and learning environments to ensure their strategic utilization in enhancing the educational experience. In conclusion, this study confirms the growing importance of social media in engineering education, highlighting its potential as a versatile tool for enhancing teaching and learning processes. The insights obtained lay the groundwork for further exploration and development in this rapidly evolving field.

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