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The relationship between social media and professional learning from the perspective of pre-service teachers: A survey

Tugen Xu[1] · Qi Gao[1] · Xinzhu Ge[1] · Jijian Lu[1]

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Abstract

Social media usage is indispensable for college students, but the connection between social media and learning has received little scientific investigation. By examining pre-service teachers' attention to science, technology, engineering, and mathematics (STEM) teaching content and presentation in social media apps through WeChat, DingTalk, and TikTok, this study aimed to provide suggestions on using social media apps to promote pre-service teachers' skill learning and teaching development and to understand the relationship between social media and learning. 383 valid surveys were distributed and gathered. The findings indicate that: 1) Social media apps have both beneficial and detrimental effects on education. 2) The degree of agreement differs on "Social media app is an excellent teaching tool" and "social media app has significant promise in boosting educational development". The highest and lowest levels of agreement degrees were obtained for DingTalk and TikTok. The level of identification also affects how much pre-service teachers may pay attention to educational research and how frequently they study new materials in the future. 3) The degree to which pre-service teachers' academic performance in professional learning is affected by their use of social media varies. These findings have implications for pre-service teachers. This study suggests that it is necessary to further investigate the teaching aid function of social media apps and how pre-service teachers can better utilize them to develop professional skills.

✉ Jijian Lu
lujijian@foxmail.com

Tugen Xu
xutugen@163.com

Qi Gao
550572284@qq.com

Xinzhu Ge
gexinzhu2019@163.com

[1] Hangzhou Normal University, NO.2318, Yuhangtang Rd, Yuhang District, 311121 Hangzhou, Zhejiang, People's Republic of China

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1 Introduction

The rapid development of Web 2.0 technologies has improved people's life quality and work efficiency. Kaplan and Haenlein define social media as "An application that allows users to develop and exchange information based on Web 2.0 technology" (Kaplan & Haenlein, 2010). WeChat, one of the most popular social media platforms, is a representative product of the web 2.0 era, and it has the basic function of "sharing and participation", i.e., the most important feature of Web 2.0 (Ding et al., 2009). WeChat has become a part of people's daily life in China and is now widely known and used. According to the most recent Tencent Q1 2022 earnings report, WeChat has amassed 1.29 billion monthly active users. WeChat users can chat with each other, share their lives, play games, and connect to various Internet gadgets. This allows for everything from light amusement to informative interactions (Xu et al., 2015).

With the development of Internet technology, Web 2.0 technology is also moving towards the Web 3.0 era characterized by networking and individuation. Social media has not only a social impact but also academic value, which greatly affects students' academic performance (Tian & Wang, 2010). For instance, WeChat enables users to host academic seminars, share cutting-edge research and thoughts, and learn numerous academic subjects attributed to the recently developed video channel feature. WeChat is not the only social media platform that Chinese university students frequently use for their academics; these platforms also include DingTalk and TikTok, which present both potential and difficulties for the higher education sector. The Web 3.0 era gave birth to apps like DingTalk, TikTok, and WeChat's new video channel function. Smartphones, social networks, Web 2.0, cloud computing, and evolving business models are all important parts of Web 3.0, which combine modern new technology (Newman et al., 2016).

Because of its powerful capabilities, DingTalk has become the main platform for live teaching, video conferencing, and team collaboration after the breakout of COVID-19 in 2020 (Xiao et al., 2020). Meanwhile, science, technology, engineering, and mathematics (STEM) education is acknowledged as a future route for the most recent educational advancements related to the future growth and profitability of a nation. STEM education integrates multiple disciplines, including learning methods and knowledge content, to develop students' literacy and enhance their capabilities to solve real problems. Therefore, it is expected that social media is connected with learning, especially STEM learning, and it can be used to promote awareness and understanding of STEM education among pupils (Zhou et al., 2022).

The two areas of previous research are the educational use of social media and the impact of social media use on academic achievement. First, social media is more and more used as a powerful educational tool. Social media, for instance, is a useful instrument for two-way communication between students and teachers, which facilitates interactions between the two groups of people in teaching and learning (Al-Rahmi et al., 2015). However, barriers exist in the

real world, and its instructional use is not very common. Second, there is disagreement over the connection between social media use and academic achievement. According to some academics, social media use negatively affects academic achievement (Feng et al., 2019; Wohn & LaRose, 2014). Others experts (Al-Yafi et al., 2018; Pasek & Hargittai, 2009), who do not support this view, point out that social media use has no impact on academic achievement. Meanwhile, other scholars believe that social media has a positive impact on academic performance (Kolek & Saunders, 2008; Tayseer et al., 2014). Most of the aforementioned studies take Facebook rather than other social media platforms like WeChat and DingTalk as the study object. However, the social media platforms investigated in this research differ from Facebook in terms of cultural context and usage patterns, making it impossible to directly extrapolate from Facebook studies to explain the connection between social media platforms and learning. Meanwhile, the subjects of the above research are usually primary and secondary school students or college students. However, few studies have investigated the relationship between social media and professional learning from the perspective of pre-service teachers. As pre-service teachers who have not formally entered the field of education and teaching but have mastered certain professional knowledge, skills, and concepts, they should reasonably apply social media to develop themselves in the professional training process. Previous studies have investigated pre-service teachers' perceptions of the importance and assistance of digital technology to their learning and teaching, as well as their perceived competence and interest level in digital technology (Polly et al., 2022). However, they have not focused on specific social media apps or the relationship between social media use and the development of STEM professional literacy of pre-service teachers. To take a more expert look at the relationship between social media and learning from the perspective of pre-service instructors, the respondents of this study were limited to pre-service teachers.

This study adopted a questionnaire survey to investigate pre-service teachers' perceptions and attitudes toward social media apps like WeChat, DingTalk, and TikTok, and investigated how social media use affects pre-service teachers' academic performance in professional learning. Also, pre-service teachers' perceptions and attitudes toward social media and their attention to STEM teaching content and presentation in social media apps were examined through data statistics with SPSS26.0. Finally, the data results were discussed, and a conclusion was drawn. This study focuses on social media and its pedagogical features, which have significant practical ramifications for social media-assisted instruction and pre-service teachers' acquisition of teaching techniques. In addition, this study pays special attention to the auxiliary role of WeChat and TikTok video channel functions for pre-service teachers' STEM learning, thus providing certain data support for global research on the relationship between social media and education and teaching. The rest of this paper is organized as follows: Section 2 theoretically reviews the use of social media in teaching and learning and defines social media and STEM education. The research topics and research techniques are discussed in Section 3. The research findings are presented in Section 4. Section 5 analyzes the research results and their consequences. Finally, Section 6 concludes this paper.

2 Literature review

2.1 Social media: WeChat, DingTalk, and Tiktok

Social media is now an integral aspect of everyone's lives in the Web 2.0 era. Web 2.0 places more emphasis on user engagement and information sharing than Web 1.0. Social media has three unique characteristics (Güler, 2015). First, social media is built on the Internet, which has a potent capacity for connection and prioritizes human ties over business-related interactions. Second, users are not simply content consumers; they are also content producers and distributors. Thirdly, social media relies on robust big data technical infrastructure that enables precise analysis and content syndication. Therefore, social media is revolutionary for teaching and learning because of its open, communicative, and social nature (Manca & Ranieri, 2016). At present, there are many types of social media, and they are more interactive than unidirectional sharing platforms such as Twitter, Weibo, and TikTok (Zeng & Song, 2018). WeChat and DingTalk are more private (Zhao et al., 2008), and they are made to facilitate information sharing and dissemination among users' "friends."

Different social media platforms have their distinctive qualities. One of the most widely used social media platforms in China is WeChat, which was introduced by Tencent in January 2011 for smartphones, tablets, and PCs (Xu et al., 2015). WeChat enables the exchange of voice, text, pictures, videos, and messages through mobile devices. Meanwhile, information on WeChat is only shared among ordinary friends and is not open to the public (Wang et al., 2016), thus protecting the privacy of users. However, if you want to provide scholarly stuff that is open to the public and not just your friends, you can apply for a WeChat public number and put content on the public number. WeChat can assist academics in fast disseminating their study findings as the primary purpose of a social media tool. Social media is increasingly popular in academic communication (Kim & Abbas, 2010; Linh, 2008; Shih, 2011),Social media tools are used to their full potential to expand the digital resources and services of some university libraries (Harinarayana & Raju, 2010; Liu, 2008). For instance, college students can directly check the collection and borrowing status of their school library on WeChat, which becomes increasingly important in fostering information exchange.

TikTok and DingTalk are both products of the Web 3.0 era. Developed by Alibaba Group, DingTalk is a free multi-end platform for communication and collaboration, especially for Chinese businesses. It has capabilities for online business, communication, organizing, and education. The platform has both an office and a teaching role, and it is primarily used in businesses. The teaching interaction, management, and resource functions of the DingTalk social media platform are the key divisions of the teaching function. Teaching interaction refers to the ability of teachers and students to interact and communicate through the interactive features provided by the platform, which helps to improve the efficiency of teaching operations. Course management and statistics make up DingTalk's

teaching management division. Besides, course management is a set of actions that teaching supervisors take to monitor, summarize, and analyze how students are learning in online courses, and to intervene and provide feedback when issues are discovered. Most attendance data are included in data statistics. Additionally, learning materials, insights, shared files, and other items can be recorded using the DingTalk journal and DingTalk disk features. Moreover, it offers digital teaching tools to promote information-based educational activities.

TikTok has become one of the most famous social media platforms. By December 2021, it has overtaken popular apps like Google and Facebook to become the most visited website in 2021 (Yelamos-Guerra & Garcia-Gamez, 2022). Since its release, TikTok, a social media app that specializes in producing and sharing short videos, has been devoted to building an online amusement and connection community. The foundation of TikTok is creating short videos of 15 s and one minute long, giving consumers a way to flexibly share various imaginative videos. These short videos span widely in subject matter, from dance and cuisine to comedy (Zhang, 2021). However, the educational potential of TikTok has been largely overlooked, and most studies investigating educational innovation have focused on other social media apps such as Twitter (Junco, 2012) and even Facebook (Kasuma, 2017; Ucar & Göksel, 2020). According to the findings of a poll on college students' opinions about using Facebook to learn English, most students express very favorable views (Shih, 2011). As a result, TikTok, which started as a community for entertainment, can now function as a comprehensive platform that provides online activism, education, and other services. According to the TikTok 2019 Annual Report, TikTok has grown to be a leading communication platform for traditional Chinese culture, knowledge, and art. A total of 14.89 million movies for the spread of information were created and watched about 100,000 times last year, more than 130 million of which were of Mr. Chen's chemistry class. Additionally, there are several video clips about traditional Chinese culture, which greatly help to promote and disseminate our traditional culture.

2.2 Pedagogical applications of social media

Social media is a web-based tool that enables users to share, communicate, and work together. There is a rising corpus of new studies on social media, and it is estimated that 3.96 billion people will be using social media globally by 2021, with an average annual growth rate of 12.5%. Social media can be exploited in education to facilitate learning and educational experiences, according to research (Greenhow et al., 2009). Since social media encourages social contact among students, it can be developed as an effective teaching tool (Kimmons et al., 2017). Meanwhile, social media can be utilized in higher education to disseminate educational resources and information as well as to promote collaboration and communication. Besides, social media supports individualized instruction (Dabbagh & Reo, 2011). Students can enhance self-regulation by tracking their learning process and that of their peers (Gammon & White, 2011; Matzat & Vrieling, 2016) to check for gaps or to make adjustments.

Although social media, represented by WeChat and TikTok, have entered into students' daily lives and are frequently used for educational activities, teachers are less likely to incorporate social media into their practices. This results in a lack of pedagogical use of social media in actual higher education teaching (Manca & Ranieri, 2016). According to the interviews with teachers about their attitudes toward using social media in higher education, most teachers have positive attitudes toward using social media for teaching and learning, and the main reason they are less likely to use social media for teaching and learning is that it introduces uncertainty into the teaching process (MacDonald et al., 2020).

To effectively use social media, it is essential to know the attitudes of pre-service and in-service teachers towards the use of social media in teaching. Although studies have investigated pre-service teachers' attitudes toward the importance and assistance of digital technology in teaching and learning, they consider that social media is less helpful to teaching and learning than learning management systems, collaboration tools, and complementary videos (Polly et al., 2022). However, most of the survey results show that pre-service teachers believe that social media can promote students' learning and develop critical thinking (Mason, 2006). In addition, social media is conducive to language learning and promotes students' learning motivation (Baſöz, 2016).

Micro-course is short for micro-video network course. It mainly explains important knowledge points in short videos according to the requirements of course standards in the form of video, providing an online course resource that supports various learning methods. Its advantages over traditional teaching include a clear topic, condensed lesson length, and free options. Currently, micro-courses have been taken as a novel teaching approach to supplement conventional teaching strategies. In addition to assisting in individual learning outside of class in elementary and secondary school instruction, it is regarded as a crucial component of Chinese higher education. Micro-courses have been shown to increase students' cognitive efficiency and diversify the teaching material (Lv et al., 2020). The video channel function of WeChat and TikTok provides a new communication method for teaching micro-course videos, which is worth further investigation.

2.3 STEM education

With implications for the literacy of a country's citizens and the future development of society as a whole, STEM education is recognized as highly promising in the most recent advancements in educational research (Zhou et al., 2022). STEM has also attracted a lot of interest from the media and educational reform around the world. To better educate all students to become global citizens, the International Council of Science Education Associations (ICASE, 2013) recently asked member states to collaborate to increase access to STEM education. However, there is no agreement among academics on what constitutes STEM education, and several definitions have been proposed. The concept of STEM education has just been formalized recently. Since the 1990s, educators have been assisting children in expanding their interest in studying STEM fields. At this time, the National Science Foundation

(NSF) incorporated engineering, technology, science, and mathematics into undergraduate and K-12 schooling. It created the acronym SMET (Science, Mathematics, Engineering, and Technology), which was later used by other agencies, including the U.S. Congress, such as the House Science Committee (Li et al., 2020). Subsequently, NSF replaced SMET with STEM (Chute, 2009), which has become the preferred acronym.

Some scholars believe that disciplines can be treated separately, and they define STEM education as problem-solving based on scientific and mathematical concepts and procedures including the use of applied engineering strategies and techniques. Others regard it as an integrated whole (Sanders, 2008), and the original use of the term "integrated STEM education" attempted to understand all STEM disciplines as a cohesive entity, with the integration and coordination of all STEM disciplines through solving real-world problems. This definition is similar to the one established by Merrill, who regarded STEM disciplines as a meta-discipline based on learning standards, with an integrated approach to teaching and indivisible learning and specific content. However, Merrill and Daugherty emphasized that "STEM education" refers to the application of an integrated approach to learning in two or more related disciplines (Merrill & Daugherty, 2009). Bybee considered STEM education as a spectrum with a core "interdisciplinary nature" that focuses on solving real-world problems (Bybee, 2013). To sum up, STEM education is the integration of knowledge content, disciplinary thinking, and teaching and learning methods of multiple disciplines for solving real problems. It is closely related to "core literacy" and "project-based learning", which are the concerns of current education.

The literature (Vlasopoulou et al., 2021) extensively discusses the importance of teachers' beliefs and attitudes toward the daily use of educational technologies in teaching practices. Meanwhile, teachers' attitudes affect the use of social digital media in daily teaching practices (Papadakis & Orfanakis, 2017). Studies have shown that meaningful STEM professional development has a positive impact on teachers' attitudes (MacDonald et al., 2020). Therefore, it is very necessary for pre-service teachers to understand STEM-related information to help students develop STEM literacy when they enter the workplace in the future (Papadakis & Orfanakis, 2017).

3 Summary

Through the above literature review, this paper aims to investigate three topics: pre-service teachers' perceptions and attitudes toward the development of social media apps, their attention to STEM teaching content and presentation in social media apps, as well as the impact of pre-service teachers' social media use on academic achievement in professional learning. These three topics were chosen for the following reasons: first, attitudes can serve as the best predictor of students' average achievement (Hendrickson, 1997). This paper first investigates students' perceptions of the effects of social media like WeChat on learning to better illustrate the connection between social media and students' academic achievement in professional learning. Second, pre-service teachers should and must prepare the future workforce

through STEM education research, which is the current trend in educational development. Also, to improve STEM teaching and learning, it is crucial to comprehend pre-service teachers' attention to STEM teaching content and presentation in social media apps of the growth of social media on learning when studying the effects of social media on learning. Finally, this paper considers the impact of various indicators on academic performance in professional learning, including gender, grade level, subject specialization direction, parents' education level, and use frequency of social media apps, thus visually demonstrating the impact of social media on learning. In this paper, academic performance is chosen as the most direct learning indicator.

4 Methodology

The purpose of this study is to investigate the relationship between social media and teacher skill learning from the perspective of pre-service teachers and attempt to address the following research questions.

Q1: What are the attitudes of pre-service teachers towards the influence of social media apps on learning and teaching?
Q2: Differences in pre-service teachers' attention to STEM teaching content and presentation in social media apps?
Q3: How does pre-service teachers' use of social media apps affect academic performance in professional learning?

The study aims to analyze the relationship between the use of social media apps and academic performance by investigating pre-service teachers' attitudes towards the influence of social media apps such as WeChat, DingTalk, and TikTok on learning and their use of social media apps for teachers' skill learning. STEM education is the development focus of the education field in the future. Based on the survey results of pre-service teachers' attention to STEM teaching content and presentation on video channel functions of WeChat and TikTok, this study suggests better use of social media as a teaching aid for pre-service teachers in the future.

4.1 Participants

The data were collected by online questionnaire survey, and the sample included 383 undergraduates and postgraduates from various courses of teachers at Hangzhou Normal University. 150 men (39.16%) and 233 women (60.84%) from various disciplines in mathematics, science, physics, chemistry, biology, and geography made up the sample. 19.58% of the participants were first-year college students, 11.49% were second-year students, 61.88% were third-year students, 4.96% were fourth-year students, and the remaining 2.09% were graduate students.

4.2 Measures

At present, WeChat, DingTalk, and TikTok are the social media apps commonly used by pre-service teachers in their daily life. Considering most pre-service teachers' familiarity with the functions of the three types of social software, our study investigates the relationship between social media and professional learning from the perspective of pre-service teachers. By using an online questionnaire platform called "Wenjuanxing", empirical data were gathered for this study. After the questionnaire is made, five teachers who guide the teaching theory of normal students at Hangzhou Normal University are responsible for sending the link of the questionnaire to the undergraduates and postgraduates of the normal major in the university through DingTalk. A total of 405 questionnaires were received, of which 383 were valid. The proportion of valid questionnaires was 94.57%.

4.2.1 Instrument

The questionnaire design of this study refers to the research by Rujing Hou et al. on the relationship between WeChat and learning from the perspective of college students (Hou et al., 2021) Based on the research theme, the questionnaire was divided into four sections: basic information, attitudes about the connection between social media apps and teaching development, behaviors about the connection between social media apps and teaching development, and the relationship between teaching development and video channel functions of WeChat and TikTok. The questionnaire was composed of 21 questions. Except for the penultimate question, which evaluated the connection between social media and learning from the perspective of pre-service teachers, the questionnaire only allowed for closed-ended responses. To answer the three research questions in this study, the open-ended answers to the last question were gathered from the questionnaire, and they were analyzed qualitatively to extract meaningful segments and obtain pre-service teachers' perceptions and suggestions about the relationship between social media and instructional development.

4.2.2 Basic information

To describe the control variables required for the model, respondents were asked for personal information, including gender, subject specialization orientation, grade level, educational background of parents, and grade point average (GPA). Then, SPSS 26.0 was used to establish the linear regression relationship between personal information variables and STEM-related social media learning attitude and engagement, as well as GPA.

4.2.3 Attitudes toward the relationship between social media apps and teaching development

The respondents were asked to answer which social media platforms they were using and their attitudes about the impact of using social media apps on

knowledge acquisition, skill enhancement for teaching, etc. Meanwhile, the respondents were asked whether they agreed that social media was an effective teaching aid, whether they agreed that social media had greater potential to contribute to instructional development, and whether using it for entertainment by students during instruction results in a decrease in instructional effectiveness. The level of agreement of the respondents was also measured with a five-point Likert scale, ranging from "disagree(1)" to "agree(5)". The influence of different social media apps on respondents' attitudes was tested by one-way ANOVA using SPSS 26.0.

4.2.4 Behaviors of the connection between social media apps and teaching development

The use frequency of WeChat, DingTalk, and TikTok is divided into three categories: information interaction frequency, content update frequency, and leisure and entertainment frequency. Logging in to view, having private conversations, liking and commenting on friends' circles, viewing subscribed public numbers, etc. are all examples of information interaction. The frequency of content updates includes sharing links, publishing to friends, etc. The frequency of leisure and entertainment is measured by using a five-point Likert scale, ranging from "never(1)" to "often(5)". Additionally, to understand the respondents' primary motivation for utilizing social media, the respondents' actions using social media apps like WeChat, DingTalk, and TikTok to promote teaching knowledge acquisition or skill enhancement, were also investigated. Finally, SPSS 26.0 was used to calculate the mean value and standard deviation of the frequency of using social media apps, as well as the linear regression relation of frequency and GPA. Then, the identification degree of pre-service teachers on using social media apps to promote knowledge and ability development, as well as the relationship between using social media apps and academic performance was analyzed.

4.2.5 Relationship between teaching development and video channel functions of WeChat and TikTok

It is necessary for pre-service teachers to learn that STEM is a future developmental force in educational research and helps students understand multiple disciplines and solve real-world problems. The respondents were asked to respond to their likely level of interest in STEM-related instructional video channels, subject preferences for content, content presentation, and frequency of follow-up learning. Instructional video channels were categorized into WeChat video channels and TikTok video channels. Then, the likelihood of following and the frequency of subsequent learning were measured using a five-point Likert scale. Based on this, the effect of social media functions on teaching development through the investigation results of WeChat and TikTok video channels and teaching development was analyzed.

5 Results

5.1 Q1: What are the attitudes of pre-service teachers towards the influence of social media apps on learning and teaching, such as WeChat, DingTalk, and TikTok video numbers?

5.1.1 The impact of social media on learning and its potential to promote teaching development

WeChat (95.04%) is the most popular social network app, followed by QQ (85.12%) and DingTalk (77.55%), while some respondents also use Weibo, TikTok, Bilibili, etc. In the survey, 21.15% of the respondents considered that WeChat encourages learning, while more than half of the respondents believed that WeChat has both good and negative influences on learning. Only 2.09% of the respondents believed that WeChat has a detrimental effect on learning, while 22.98% believed it has no effect on learning.

According to pre-service teachers' perceptions of the effects of DingTalk and TikTok on learning, nearly half of the respondents believed that DingTalk will positively affect teaching knowledge acquisition and skill improvement, while only 4.7% of the respondents believed that TikTok can positively impact learning, and 1/5 believed that TikTok will negatively impact learning. This result indicates that most respondents have a negative or mixed attitude to TikTok, whereas most of them think that DingTalk has a favorable impact on learning (Table 1).

The statements "social media apps such as WeChat, DingTalk, and TikTok has greater potential in promoting teaching and learning" and "social media apps such as WeChat, DingTalk, and TikTok is an effective teaching aid" received higher positive ratings from more than half of the respondents, but the assessments of the three social media apps varied greatly. The respondents' levels of agreement were surveyed using a five-point Likert scale, ranging from "disagree" to "agree" on a scale of 1–5. For the statement that "social media app is an effective teaching aid", the average approval degree for WeChat, DingTalk, and TikTok was 3.56, 4.18, and 2.58, respectively. The p values of the differences between the groups were all smaller than 0.001. That is, for this statement, the respondents had the highest degree of approval for DingTalk and the lowest degree of approval for TikTok. There were significant differences in the respondents' recognition of different social media apps as effective teaching aids. Similar to the previous result, the average degree of agreement with the statement that WeChat, DingTalk, and TikTok have great potential in promoting teaching development was 3.58, 4.10, and 2.78, respectively. The differences between the groups were also significant. To sum up, most respondents believed that DingTalk has advanced teaching, followed by WeChat and TikTok. Meanwhile, the results of the question "using social media for entertainment while teaching leads to lower teaching efficiency" show that about 80% of the respondents believe that using TikTok in the classroom will reduce teaching effectiveness. The percentage for WeChat and DingTalk is slightly lower at about 55% and 30%, respectively.

Table 1 Variation analysis on pre-service teachers' attitudes towards the relationship between different social media apps and teaching development

Statements	Social media app	N	Mean	Standard deviation	F	Result of Post Hoc
Social media app is an effective teaching aid	WeChat	383	3.56	1.11	199.08***	DingTalk > WeChat > TikTok
	DingTalk	383	4.18	0.93		
	TikTok	383	2.58	1.29		
Social media app has greater potential in promoting teaching and learning	WeChat	383	3.58	1.10	130.25***	DingTalk > WeChat > TikTok
	DingTalk	383	4.10	0.97		
	TikTok	383	2.78	1.32		

***$P < 0.001$

5.1.2 Social media apps activities and learning behavior

A five-point Likert scale was used to evaluate the frequency of participation in social media activities (1 = "never," 2 = "rarely," 3 = "usually," 4 = "more frequently," and 5 = "regular"). According to the findings, information interaction frequency (M = 3.17) is the highest, followed by content update frequency (M = 2.49) and leisure and entertainment frequency (M = 2.73). WeChat has the highest information interaction frequency (M = 3.88, SD = 1.031), followed by DingTalk (M = 3.17, SD = 1.070) and TikTok (M = 2.45, SD = 1.387), and the respondents' use of social media was essentially information interaction. Also, WeChat had the highest content update frequency (M = 3.13, SD = 1.154) and leisure and entertainment frequency (M = 3.45, SD = 1.201), whereas DingTalk and TikTok were more comparable, with TikTok having a slightly higher recreation frequency than DingTalk. The specific results are presented in Table 2.

WeChat was used for learning activities such as "acquiring teaching knowledge" (47%), "publishing teaching-related information" (33.16%), "discussing teaching concerns with peers" (70.76%), "consulting with instructors or seniors about teaching issues" (60.31%), and other activities like swiping through videos, exchanging files, etc. (9.4%). DingTalk was used by 56.4%, 43.34%, 49.35%, 70.5%, and 7.31% of the respondents for the aforementioned learning exercises, respectively; TikTok was used by 19.84%, 8.09%, 11.23%, 8.09%, and 11.75% of the respondents for the aforementioned learning exercises, respectively. These results indicate that pre-service teachers used TikTok more for fun than learning, and a substantial percentage of respondents (62.92%) stated that they were not using it to advance their knowledge and skills. According to more than half of the respondents, WeChat and DingTalk provide crucial forums for students to exchange information and support one another. For learning activities involving "receiving and posting teaching-related information," the respondents favor using DingTalk more frequently than WeChat or WeChat for talking with teachers or other authority figures. This demonstrates that there is much opportunity for future DingTalk development to support teaching knowledge acquisition or skill development.

Table 2 Frequency evaluation of Social media activities

Activity item		Mean/M	Standard deviation/ SD
Information Interaction	WeChat	3.88	1.031
(M = 3.17)	DingTalk	3.17	1.070
	TikTok	2.45	1.387
Content Updates	WeChat	3.13	1.154
(M = 2.49)	DingTalk	2.33	1.253
	TikTok	2.00	1.244
Leisure and entertainment	WeChat	3.45	1.201
(M = 2.73)	DingTalk	2.30	1.200
	TikTok	2.43	1.422

5.2 Q2: Differences in pre-service teachers' attention to STEM teaching content and presentation in social media apps?

In terms of pre-service teachers' attention to STEM teaching content and presentation in social media apps, 14.1% of the respondents chose to "not", 10.18% chose to "probably not ", 19.84% chose "generally", 45.17% chose "maybe", and 10.7% chose "definitely" follow STEM-related WeChat video channels. Meanwhile, 28.46% of the respondents chose "won't", 12.53% chose "probably won't", 17.75% chose "generally", 32.64% chose "probably", 32.64% chose "probably will", and 8.62% chose "definitely will" follow related TikTok teaching video channels. Besides, the pre-service teachers were more likely to pay attention to STEM-related WeChat video channels than to TikTok video channels. Since this part of the survey focused on pre-service teachers' attention to STEM teaching content and presentation in WeChat video channels and TikTok video channels, there is no such function in the DingTalk app, so no investigation and analysis were conducted.

The popularity and correlation analysis of the STEM teaching video channel in WeChat and TikTok is shown in Table 3. Except for the two options of "other" and "not interested in", the proportion of attention to STEM-related topics is greater for WeChat video channels than for TikTok video channels, indicating that the respondents tend to choose WeChat's video function to obtain teaching knowledge. Meanwhile, the respondents preferred teaching video channels about "science", followed by "STEM synthesis". "Technology", and "Engineering". The correlation analysis results between WeChat video channels and TikTok video channels show a significant correlation, and the correlation coefficient between the number of followers of STEM-related topics of the two types of video channels is 0.731.

In terms of the awareness of social media apps and STEM teaching development, the content released by STEM-related teaching video channels of science, technology, engineering, and mathematics can be mainly divided into three categories: subject content knowledge, subject technical knowledge, and subject teaching knowledge. The respondents paid the most attention to subject teaching knowledge (WeChat 54.83%, Tiktok 40.47%). Meanwhile, 38.64% and 21.93% of the respondents chose not to be interested in STEM-related teaching videos released by Tiktok videos or WeChat videos. In terms of content presentation, the preferences for real-life presentation (44.13% in WeChat and 32.64% in TikTok), live-action presentation (39.16% and 30.29%), and subtitle presentation (41.78% and 32.64%) ranked the top three.

Finally, multiple linear regression analyses were conducted to determine the influencing factors of the possible degree of attention and frequency of subsequent learning of STEM-related instructional video channels, and the significant results are listed in Table 4.

According to the results in this table, the respondents' recognition of the potential of social media to promote teaching development and their recognition of WeChat and TikTok as effective teaching aids are significantly correlated with their attention to STEM-related WeChat and TikTok video accounts and subsequent learning frequency. Meanwhile, subject specialization and GPA were significantly associated with the likely level of attention to WeChat and TikTok video channels, respectively.

Table 3 The popularity and correlation analysis of WeChat and TikTok STEM teaching video channel

	Science				Technology	Engineering	Math	STEM	Sig.(2-tailed)
	Physics	Chemistry	Biology	Geography					
WeChat Video Channel	125	172	137	81	74	43	97	125	0.011*
TikTok Video Channel	78	129	104	62	54	26	66	89	

***$P < 0.001$, **$P < 0.01$, *$P < 0.05$

Table 4 Multiple linear regression analysis of social media and professional learning from the perspective of pre-service teachers ($N = 383$)

Variables	Concern extent of WeChat Video Channel	Concern extent of TikTok Video Channel	Subsequent learning frequency of WeChat Video Channel	Subsequent learning frequency of TikTok Video Channel
Gender	0.760	0.268	0.379	0.383
Discipline direction	0.042*	0.389	0.806	0.761
Grade	0.721	0.686	0.230	0.348
Father's education level	0.116	0.962	0.578	0.307
Mother's education level	0.194	0.464	0.753	0.450
GPA	0.354	0.039*	0.578	0.679
The influence of Wechat/Tiktok on development	0.827	0.143	0.265	0.139
The degree of recognition of WeChat/TikTok as a teaching aid	0.042*	0.030*	0.120	0.176
The potential of WeChat/TikTok to promote teaching	0.001***	0.000***	0.000***	0.000***

***$P < 0.001$, **$P < 0.01$, *$P < 0.05$

5.3 Q3: How does pre-service teachers' use of social media apps affect academic performance in professional learning?

GPA can most intuitively reflect the effect of students' professional learning, so this paper adopted GPA to measure the academic performance of pre-service teachers. Since GPA was calculated differently for undergraduate and graduate students, the survey results were manually processed to ensure measurement consistency, and finally, 383 pieces of valid data were obtained.

Possible influencing variables were selected for stratified (block) linear regression analysis to determine which variables could be used to predict GPA. Compared to model 1, the independent variables of model 2 added content update frequency, leisure and entertainment frequency, and information interaction frequency. The specific results are presented in Table 5.

In model 1, gender ($\beta = 0.302$, $P < 0.001$) and father's education ($\beta = 0.136$, $P < 0.05$) had a positive and significant effect on GPA; subject specialization orientation ($\beta = 0.026$, $P > 0.1$), grade ($\beta = 0.033$, $P > 0.1$), and mother's education ($\beta = -0.043$, $P > 0.1$)) had no significant effect on GPA and failed to predict academic performance. The independent variable of gender can significantly affect the GPA of pre-service teachers probably because of the differences in learning styles, learning attitudes, and the ratio of men to women on credit evaluation activities such as coursework and educational internships. However, this relationship needs further confirmation by discussion and validation. In contrast, the positive and significant effect of father's education on GPA may be due to the influence on children's education style and thus indirectly affect children's academic performance.

Table 5 Hierarchical linear regression analysis of social media and professional learning from the perspective of pre-service teachers ($N = 383$)

Variables	Model 1		Model2	
	β	VIF	β	VIF
Gender	0.302***	1.025	0.267***	1.107
Discipline direction	0.026	1.126	0.018	1.173
Grade	0.033	1.103	0.036	1.130
Father's education level	0.136*	1.818	0.125*	1.889
Mother's education level	–0.043	1.810	–0.025	1.873
Information interaction frequency (WeChat)			0.155*	2.233
Information interaction frequency (DingTalk)			–0.036	1.960
Information interaction frequency (TikTok)			–0.061	3.753
Content update frequency(WeChat)			0.110	2.379
Content update frequency(DingTalk)			–0.020	2.711
Content update frequency(TikTok)			–0.010	2.850
Leisure and Entertainment frequency(WeChat)			0.000	1.986
Leisure and Entertainment frequency(DingTalk)			0.110*	1.950
Leisure and Entertainment frequency(TikTok)			–0.022	3.794

βis standardized coefficients; ***$P < 0.001$, **$P < 0.01$, *$P < 0.05$

In Model 2, the results of the added independent variables indicated no significant effect of content update frequency on GPA for all three social media apps. The information interaction frequency for WeChat ($\beta = 0.155$, $P < 0.05$) and the leisure and entertainment frequency for DingTalk ($\beta = 0.110$, $P < 0.05$) had a positive and significant effect on GPA, and other frequencies of use had no significant effect on GPA. Combined with the results in Q1, this may be because the respondents use DingTalk entertainment mainly to consult on teaching problems or obtain teaching information, etc., and WeChat's information interaction also includes communication with peers for learning, which are all related to work and study. Thus, it is believed that they do not affect teaching efficiency but rather promote the respondents to eventually achieve better academic performance.

The R^2 for model 1 ($R^2 = 0.100$) and model 2 ($R^2 = 0.154$) is greater than the critical value of 0.1, indicating that both models are acceptable. Comparing the R^2 of model 1 and model 2, it was found that the introduction of independent variables increased the R^2 from 10.0% to 15.4% ($\Delta R^2 = 5.4\%$, $\Delta F = 5.825$, $P < 0.05$). The addition of the three independent variables, i.e., information interaction frequency, content update frequency, and leisure and entertainment frequency, increased the explanatory power by nearly half, and thus the focus on them is meaningful. With the increased explanatory power of the model, Model 2 was better constructed. In addition, the Variance Inflation Factor (VIF) of both models met the criteria, indicating that there were no multicollinearity problems.

6 Discussion

6.1 Findings

This study examines pre-service teachers' attention to STEM teaching content and presentation in social media apps, their perceptions and attitudes toward the development of social media apps and STEM instruction, as well as the impact of social media app use on academic achievement in professional learning.

First, the impact of social media apps on learning is considered a "double-edged sword", i.e., they have both positive and negative effects on learning. This result has been verified by previous studies (Carpenter & Krutka, 2014; Krutka & Milton, 2013) This study compared three social media apps and found that the respondents had different attitudes toward the impact of social apps on learning. The attitudinal difference is reflected in that the respondents were more supportive of using DingTalk in teaching and believed that the high use frequency of DingTalk has a positive impact on teaching development, while many respondents think that the high use frequency of TikTok will have a negative impact on teaching. In fact, in higher education, social media has long been used as a tool to facilitate teacher-student communication, improve students' active learning ability and facilitate feedback (Liu, 2018). The activities that pre-service teachers use WeChat to promote teaching knowledge acquisition or skill improvement are mainly discussing teaching issues with peers around them and consulting with teachers or seniors about teaching issues. The main use of DingTalk is to ask

teachers or seniors for advice and to acquire teaching knowledge. Therefore, there is a relatively high degree of recognition that these two social media apps can provide teaching aids or have the potential to promote the development of teaching. Also, it was found that most of the respondents do not use TikTok for their development. Some scholars believe that the use of social media apps in teaching will affect students' concentration (Richtel, 2011). The social entertainment of TikTok may be the reason why pre-service teachers hold different attitudes toward it. To sum up, social media apps have a significant impact on learning, so there is much room for future development in using social media apps to facilitate teaching knowledge acquisition, skill improvement, etc.

Second, in terms of the differences in attention on STEM teaching content and presentation in social media apps, more than half of the pre-service teachers surveyed stated that they are likely to follow STEM-related WeChat video channels, and the percentage is higher than that of followers to TikTok video channels. This indicates that the respondents are more likely to choose WeChat's video channel function to obtain STEM-related teaching and learning information. In previous teaching studies based on social media apps, mixed teaching combined with WeChat was trusted by teachers and students (Zhang et al., 2019). For college students, both medical studies (Wang et al., 2017) and English learning studies (Wu & Ding, 2017) both found that the teaching method combined with WeChat improved students' participation and satisfaction. All this information shows that WeChat is a relatively mature social media app suitable for teaching. The respondents preferred teaching video channels about "science", followed by "STEM synthesis". This may be related to the subject matter orientation of the respondents, and their subject matter orientation can be further investigated. In terms of the content of STEM-related teaching video channels, the survey found that the respondents paid the most attention to subject teaching knowledge, and the proportion of attention to subject content knowledge and subject technical knowledge was not much different. It is well known that subject teaching knowledge plays a vital role in teacher development (Su & Wang, 2022). This is closely related to the employment demand of normal university students. In addition, the learning of subject teaching knowledge is limited by places, tools, and people, especially the learning activities of teaching skills related to STEM topics. Due to the above limitations, some scholars attempted to conduct online tutoring for pre-service teachers (Redmond, 2015), and the function of the teaching video number is similar to that of online tutoring. Therefore, when the content related to the improvement of subject teaching knowledge is released on the convenient-learning teaching video number, it will attract more attention from pre-service teachers. Besides, the respondents preferred live-action presentation and live-action filming and captioning are more attractive to viewers than other methods. This implies that when using the video number function of social media apps as a teaching aid, it may be easier to attract students' attention in the three forms mentioned above. The respondents' agreement that WeChat and TikTok are effective teaching aids and that they have greater potential to facilitate teaching and learning significantly affected their interest in STEM-related video channels. The level of agreement on the potential to facilitate teaching and learning development was also significantly related to the subsequent learning frequency of the respondents.

Subject specialization and GPA also had varying degrees of influence on pre-service teachers' use of social media apps to follow and learn from STEM-related videos.

Third, it is an important part of educational research to determine the factors that affect academic performance in professional learning. Some studies have shown the importance of social network structure (Kassarnig et al., 2018). Our study found that the use of social media had a complex impact on the academic performance of pre-service teachers in professional learning. Gender in basic information and father's education had a positive and significant effect on academic achievement. Besides, there was a significant difference in the effect of frequently using different social media apps on academic achievement. Only the information interaction frequency of WeChat and the leisure and entertainment frequency of DingTalk had a positive and significant effect on the academic achievement of pre-service teachers.

6.2 Theoretical significance

The above findings make theoretical contributions to the current academic literature and complement the existing theoretical studies.

First, this paper investigated pre-service teachers' attitudes toward the impact of social media on learning. Previous studies focused on the functional use of social media apps and mainly examined Facebook and WeChat. In this study, in addition to WeChat, two social media apps, i.e., DingTalk and TikTok, were considered, and the role of social media in promoting teaching and learning was investigated. This study shows that most students believe that the impact of social media on learning is twofold. In fact, besides students, teachers also believe that social media can be exploited to support teaching and learning (Dyson et al., 2015; Sobaih et al., 2016), but it is rarely used in teaching practice in primary and secondary schools due to the constraints, and at present, the current percentage of using social media apps to support teaching and learning is not high in universities. It is also noteworthy that the teaching function of DingTalk was recognized by pre-service teachers in this study, so future theoretical and practical studies can pay attention to the DingTalk app in teaching. However, the results of this study do not directly indicate that the use of social media can promote teaching and learning, but rather correlate the use of social media with academic achievement through a survey of the attitudes of pre-service teachers. The research believes that the appropriate application of social media apps, such as video channels, can make them become a tool for pre-service teachers to use to some extent.

Second, this paper connects social media apps to the development of STEM education as an educational theory or a curriculum. STEAM education is gradually becoming a diversified curriculum in education, which realizes interdisciplinary knowledge construction through interdisciplinary integration (Margot & Kettler, 2019). Pre-service teachers, as guides of future student development, need to be more exposed to current cutting-edge research areas in education. This study investigated the factors that affect pre-service teachers' attention to STEM-related WeChat and TikTok video channels and the frequency

of subsequent learning. The respondents' agreement that social media has greater potential to facilitate instructional development was significantly correlated. Meanwhile, the respondents' perceptions of social media apps as an effective teaching aid, subject specialization orientation, and GPA also had varying degrees of influence on pre-service teachers' exposure to STEM-related content. More than half of the pre-service teachers surveyed stated that they were likely to follow STEM-related videos, with "science" being their focus. This study also investigated pre-service teachers' preferences for the content and content presentation of STEM-related videos. The investigation results indicate that they can be used for subsequent improvement of the video channels.

Third, this paper analyzed the influence of using social media apps on academic performance. In addition to the correlation analysis between gender, subject specialization direction, grade level, parents' education level, and academic performance in the basic information, the frequency of social media use was also included. The frequency of using different activities of social media, such as the frequency of information interaction, content updates, and leisure and entertainment, had a significant difference in academic achievement.

6.3 Practical significance

The findings have important practical implications for social media-assisted instruction and pre-service teachers' learning of teaching skills.

For pre-service teacher preparation, the total length of classroom learning for undergraduate and even plus master's degrees is undoubtedly longer than that of using social media for learning. Meanwhile, the course structure of different majors is organized in order, and the time spent using social media to study outside of class is too fragmented. Besides, some students have poor self-control, and if they spend a lot of time on social media apps for entertainment rather than studying, it will inevitably affect the study of their major courses. Therefore, it is suggested that teachers should reasonably design and use social media apps in classroom teaching, which is more organized than students' independent learning after class. Specifically, the following four suggestions are given for the practical application of social media in teaching.

First, teachers should pay attention to the relevant course content in social media and master the use of the functions. For example, freshmen and sophomores may not know much about STEM; in this case, teachers can recommend some public WeChat numbers and video channels about STEM education to students in their teaching, or share some files in DingTalk to encourage students to use social media apps to learn and increase their WeChat learning engagement and participation.

Second, social media apps play a supporting role in teaching. Therefore, when teachers use social media apps in teaching, they should design them reasonably so that they will not take up too much classroom time. When using WeChat in teaching, teachers should focus on guiding and stimulating students' interest in learning. When using social media, it is important to make students focus on the relevant learning tasks instead of using them for entertainment. Therefore, teachers should remind students of

how and how often they use social media and moderate the frequency of social media for leisure and entertainment.

Third, besides using social media apps in the classroom to assist teaching, teachers can also assign learning tasks for students' after-school social media app use. This can effectively control students' leisure activities after school and make better use of social media apps for self-improvement. In addition, considering some students' poor self-control ability and excessive use of social media under the pretext of study, teachers can take measures such as setting task time limits or benign competition to improve students' learning efficiency and reduce activities unrelated to learning caused by poor self-control.

Fourth, the pre-service teachers' motivation to use social media and their self-control is the most fundamental influencing factors on how social media can help students acquire knowledge and improve their abilities. Therefore, students should recognize the positive effects of social media on learning so that they can regulate their social media use and avoid spending too much time on socializing and entertainment. Also, students need to actively explore the research and academic functions in social media apps, e.g., some public numbers in WeChat regularly push some frontier progress in the discipline and the latest research results in the field of education.

6.4 Limitations and future research

This study has some limitations, which are possible directions for future research.

First, the data in this study are the attitudes of the respondents at a certain moment in time, and the causal relationships between different variables are not absolute. Future studies could add a temporal dimension to analyze the causal relationships between variables through changes in the data of the same respondents.

Second, in this study, GPA was used to measure the academic performance of teacher educators, but it is not clear whether GPA is the best representation. It is possible that for teacher educators, teaching skills and knowledge of teaching are more reflective of their professionalism than grades in some general education courses. Therefore, variables that measure academic performance need to be further explored, such as summative evaluations based on formative assessments rather than those reflected by GPA.

Third, the sample of this study is limited to students from Hangzhou Normal University, and the study results do not have high generalizability. Different universities have different approaches to training students. In addition, culture also affects people's social media use behaviors. Therefore, samples from different cities or regions or even different countries may lead to different results, and this needs further investigation and comparison in the future.

Fourth, the questionnaire questions in this study do not fully encompass all the variables that influence academic achievement and the attention and learning possibilities of STEM-related instructional video channels. In fact, many variables should be further investigated to examine the relationship between social media use and academic achievement, attitudes in relation to instructional development, and behaviors related to instructional development, e.g., whether college students of different genders have different attitudes towards social media to promote teaching development; whether different disciplines will affect the degree of recognition of social media applied in teaching; whether different learning styles based on social media have different influences on academic performance, etc. In future research, the introduction of additional variables will be considered, along with attention to the effects of potential variables.

7 Conclusion

It is necessary to understand the relationship between social media and learning to better use social media apps to help pre-service teachers' skill learning and teaching development. This study focuses on three research questions. Through the questionnaire in this study, it was found that, first, most pre-service teachers and students believe that social media has both positive and negative effects on learning. Second, in terms of the differences in attention to STEM teaching content and presentation methods in social media, pre-service teachers tend to choose the subject teaching knowledge pushed by WeChat video channels, and they pay the most attention to science subjects. Meanwhile, the presentation of content with real-person demonstration, real-scene shooting and subtitles is more attractive to them. Third, the results of this study indicate that the use frequency of social media apps can affect pre-service teachers' academic performance. The above findings show that the application of social media as a teaching aid in the professional learning of pre-service teachers has certain positive effects and sustainable development space. Combined with our findings and the characteristics of different social media, different teaching activities may be conducted with different types of social media to obtain better results. Relatively, TikTok applications and teaching do not have a high degree of recognition. Therefore, pre-service teachers should recognize the use of social media apps, establish the right motivation to use them, and fully utilize the teaching-supporting functions of social media. However, limitations in this study, such as selecting GPA as a variable to measure academic performance, small sample size, and ignoring the influence of some potential variables, need further investigation in the future.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable (ICASE, 2013) request.

Declarations

Conflict of interest None.

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