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INTEGRATION OF SOCIAL MEDIA INTO MATHEMATICS INSTRUCTION: EFFECTS ON STUDENT SELF-DIRECTED LEARNING SKILLS AND ACHIEVEMENT[1]

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Abstract

The increasing use of digital technologies has encouraged educators to explore innovative ways of supporting students' learning beyond classroom instruction. This study investigated the effects of social media-supported mathematics instruction on sixth-grade students' mathematics achievement and technology-based self-directed learning skills. A quasi-experimental pre-test–post-test control group design was employed with 58 sixth-grade students enrolled in a public middle school in İstanbul, Türkiye. The intervention was implemented over seven weeks using a WhatsApp group through which researcher-selected YouTube videos, Instagram posts, visual learning materials, and practice questions related to the mathematics curriculum were shared. Data were collected using a Mathematics Achievement Test and the Technology-Based Self-Directed Learning Skills Scale. The findings showed that students in the experimental group achieved significantly higher mathematics achievement scores than those in the control group. However, no statistically significant difference was found between the groups in terms of technology-based self-directed learning skills. These findings suggest that social media can serve as an effective supplementary instructional environment for improving mathematics achievement when it is integrated into teaching through well-planned pedagogical practices. At the same time, the findings indicate that developing students' technology-based self-directed learning skills may require longer implementation periods and more explicit instructional support.

Keywords: social media, mathematics instruction, self-directed learning

INTRODUCTION

Mathematics is one of the core subjects in compulsory education and plays a fundamental role in developing students' logical reasoning, analytical thinking, and problem-solving skills. Despite its importance, many middle school students experience difficulties in learning mathematics and often require additional learning opportunities beyond classroom instruction. Recent developments in educational technology have encouraged educators to utilize digital learning environments to provide students with flexible access to learning resources and continuous academic support outside school hours (Dai et al., 2025).

Among various digital technologies, social media has attracted increasing attention as a complementary instructional tool rather than merely a communication platform. Social media-supported learning environments enable students to access instructional videos, digital materials, discussion platforms, and instant feedback regardless of time and place. These characteristics allow students to revisit

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mathematical concepts, collaborate with peers, and communicate with teachers throughout the learning process. Consequently, social media has the potential to transform passive learning experiences into more active, learner-centered educational practices (Martinovic et al. 2013).

The effectiveness of technology-enhanced learning environments, however, depends not only on the technological tools themselves but also on students' ability to regulate and manage their own learning. In this regard, technology-based self-directed learning has become an increasingly important construct in contemporary education (Moore, 1996, 2013; Morgan, 1995; Garrison, 1997). Students with strong self-directed learning skills are more capable of identifying their learning needs, selecting appropriate learning resources, monitoring their own progress, and evaluating learning outcomes while using digital technologies. Therefore, technology-supported mathematics instruction should be evaluated not only in terms of academic achievement but also regarding its contribution to developing students' independent learning skills (Tan, 2013).

Although numerous studies have examined the educational use of digital technologies (Engelbrecht, Borba, & Kaiser, 2020), most have investigated online learning environments, learning management systems, or individual educational applications. Comparatively fewer studies have explored the integration of commonly used social media platforms into mathematics instruction (Ayeni & Aderinkola, 2022; Schlamp, 2024; Sorochka & Zambak, 2024) while simultaneously examining both cognitive outcomes, such as mathematics achievement, and learner-related outcomes, such as technology-based self-directed learning skills (Melgaard, Monir, Lasrado, & Fagerstrøm, 2022; Moore, 1996, 2013). Furthermore, existing research has frequently focused on university students or preservice teachers, whereas empirical evidence at the middle school level remains limited (Saracaloğlu et al., 2004; Hamutoglu et al., 2020; Melgaard et al., 2022; Bağcı & Bağcı, 2020).

Addressing this gap, the present study investigates whether systematically integrating social media into mathematics instruction contributes to improving sixth-grade students' mathematics achievement and technology-based self-directed learning skills. Unlike many previous studies that primarily evaluated students' perceptions of technology use, this study examines whether social media-supported instruction can simultaneously enhance students' academic performance and foster independent learning competencies. The findings are expected to provide practical implications for mathematics teachers seeking to integrate social media into classroom instruction and to contribute to the growing literature on technology-enhanced mathematics education.

Research Gap and Significance of the Study

Despite the growing interest in integrating social media into educational settings, empirical evidence regarding its effectiveness in mathematics education remains limited and inconclusive (Engelbrecht, Borba, & Kaiser, 2020). Previous studies have predominantly focused on students' attitudes toward technology, general online learning experiences, or academic achievement, while comparatively fewer investigations have examined whether social media-supported instruction contributes to the development of students' technology-based self-directed learning skills. Furthermore, much of the existing literature has been conducted with university students or preservice teachers, leaving a noticeable gap in research involving middle school learners.

Addressing this gap is particularly important because middle school represents a critical stage during which students begin to develop independent learning habits while simultaneously encountering increasingly complex mathematical concepts. Learning environments that combine structured instructional support with opportunities for autonomous learning may therefore play an important role in both academic achievement and lifelong learning competencies.

In the present study, the term social media-supported mathematics instruction refers to the integrated use of multiple social media applications. WhatsApp served as the primary communication platform, while YouTube videos and Instagram posts were used to provide instructional videos, visual

explanations, and supplementary learning materials. These platforms were purposefully integrated to extend learning beyond classroom instruction through an asynchronous learning environment.

Accordingly, the present study extends previous research by experimentally investigating the effects of social media-supported mathematics instruction on both mathematics achievement and technology-based self-directed learning skills among sixth-grade students. By examining these two outcomes simultaneously, the study provides a broader understanding of how social media can function as an instructional environment that supports not only cognitive achievement but also students' capacity to manage their own learning through digital technologies.

The present study was designed to address the following research questions:

RQ1. Does social media-supported mathematics instruction significantly improve sixth-grade students' mathematics achievement compared with conventional mathematics instruction?

RQ2. Does social media-supported mathematics instruction significantly improve sixth-grade students' technology-based self-directed learning skills compared with conventional mathematics instruction?

METHOD

Research Design

This study employed a quasi-experimental pre-test–post-test control group design to investigate the effects of social media-supported mathematics instruction on sixth-grade students' mathematics achievement and technology-based self-directed learning skills. A quasi-experimental design was considered appropriate because the study was conducted in an authentic school setting where existing classrooms were assigned as experimental and control groups without random assignment of individual students. This design enabled the researchers to compare changes in students' learning outcomes before and after the instructional intervention while maintaining the natural classroom environment.

The independent variable of the study was social media-supported mathematics instruction, whereas the dependent variables were mathematics achievement and technology-based self-directed learning skills. Both groups completed the pre-test before the implementation and the post-test after the instructional intervention. The effectiveness of the intervention was evaluated by comparing the changes observed in both groups.

Participants

The participants consisted of 58 sixth-grade students enrolled in a public middle school in Istanbul, Türkiye. Of these, 31 students were assigned to the experimental group and 27 students to the control group.

Before the implementation, equivalence between the groups was examined using pre-test scores. Results showed that there were no statistically significant differences between the experimental and control groups prior to the intervention, suggesting that the groups were comparable at the beginning of the study.

Participation in the study was voluntary. Necessary permissions were obtained from the relevant educational authorities, the school administration, and the participants' parents before data collection. Ethical principles regarding confidentiality, voluntary participation, and anonymity were carefully maintained throughout the research process.

Instruments

Two instruments were employed to collect the data. Students' mathematics achievement was assessed using a Mathematics Achievement Test developed in accordance with the sixth-grade mathematics curriculum. The test was designed to measure students' understanding of the mathematical concepts addressed during the instructional intervention. Mathematics achievement was measured using a researcher-developed achievement test consisting of 30 multiple-choice items covering 15 sixth-grade

mathematics learning outcomes specified in the national mathematics curriculum. The test was reviewed by subject-matter experts, piloted, and refined through item difficulty and discrimination analyses before the main implementation. Prior to its implementation, the test underwent expert review, pilot testing, and item analysis to ensure its validity and reliability.

Students' technology-based self-directed learning skills were measured using the Technology-Based Self-Directed Learning Skills Scale. The scale evaluates learners' ability to plan, monitor, regulate, and evaluate their own learning while using digital technologies. Previous studies have reported satisfactory validity and reliability evidence for the scale, and the reliability analyses conducted in the present study also demonstrated acceptable internal consistency.

Instructional Intervention

The intervention was implemented over a seven-week period, from mid-April to the first week of June 2025. A WhatsApp group was created for the students in the experimental group to facilitate communication and share instructional materials outside regular classroom hours. The WhatsApp group served as the primary communication platform through which students accessed learning resources and interacted with the teacher. The group was created exclusively for educational purposes and was used to extend learning beyond classroom instruction.

The intervention covered 15 mathematics learning outcomes included in the sixth-grade mathematics curriculum. For each learning outcome, instructional materials consisting of researcher-selected YouTube videos, Instagram posts containing visual explanations and summaries, and practice questions were shared through the WhatsApp group. These materials were designed to reinforce classroom instruction, provide additional examples, encourage repeated review of mathematical concepts, and support students' independent practice.

Students in the control group continued to receive regular mathematics instruction based on the national curriculum. They completed the teacher's routine classroom activities and homework assignments; however, they did not receive the social media-supported instructional materials or online learning activities provided to the experimental group.

The instructional activities were implemented in an asynchronous learning environment. Students could access the shared materials at their own pace, revisit them whenever necessary, and ask questions through the WhatsApp group. The teacher also provided guidance and feedback throughout the intervention to support students' learning process. Although WhatsApp served as the primary communication platform, the instructional intervention incorporated multiple social media applications. Researcher-selected YouTube videos and Instagram posts were shared through the WhatsApp group to support students' learning outside classroom hours.

Procedure

The instructional intervention was implemented during the regular mathematics course over the scheduled instructional period. The implementation covered 15 mathematics learning outcomes included in the sixth-grade mathematics curriculum. During the intervention, the experimental group received both regular classroom instruction and social media-supported learning activities, whereas the control group followed the regular mathematics curriculum without social media support.

The social media-supported learning environment was designed to extend learning beyond classroom instruction. Students in the experimental group were provided with instructional videos, visual learning materials, interactive activities, and teacher guidance through commonly used social media platforms. These digital resources enabled students to review mathematical concepts, reinforce classroom learning, communicate with the teacher when necessary, and continue learning outside school hours. Throughout the implementation, classroom instruction and online learning activities were planned as complementary components of the same instructional process.

Ethical Considerations

Ethical approval for the study was obtained from the relevant ethics committee before data collection. Official permission was also received from the Provincial Directorate of National Education. Written informed consent was obtained from the parents or legal guardians of all participating students, and participation in the study was voluntary. Confidentiality and anonymity were ensured throughout the research process.

Data Analysis

The collected data were analyzed using IBM SPSS Statistics. Prior to hypothesis testing, descriptive statistics and assumption tests were conducted to determine the distributional characteristics of the data. Depending on the normality of the distributions, both parametric and non-parametric statistical procedures were employed. Differences between the experimental and control groups were examined by comparing pre-test and post-test scores. Statistical significance was evaluated at the .05 level.

RESULTS

Mathematics Achievement

The first research question examined whether social media-supported mathematics instruction significantly affected students' mathematics achievement. Pre-test analyses indicated that there was no statistically significant difference between the experimental and control groups before the implementation. Following the intervention, the mathematics achievement scores of the experimental group increased more than those of the control group. The findings indicate that integrating social media into mathematics instruction contributed positively to students' mathematics achievement.

Preliminary analyses indicated that there was no statistically significant difference between the experimental and control groups in terms of mathematics achievement before the intervention, suggesting that the two groups were comparable at baseline. Following the instructional intervention, students in the experimental group demonstrated higher post-test mathematics achievement scores than those in the control group. The statistical analyses revealed that this difference was significant, indicating that participation in this instructional approach positively affected students' mathematics achievement.

These findings suggest that integrating social media into mathematics instruction may provide students with additional opportunities to reinforce classroom learning, revisit mathematical concepts, and engage in continuous learning beyond regular lesson hours.

Table 1. Independent Samples t-Test Results for Post-Test Scores of Experimental and Control Groups

Group	N	Mean	SD	t	df	p	Cohen's d
Control	27	10.3077	2.34554	7.376	43.610	< .001	1.87
Experimental	31	17.3000	4.62490				

Levene's test indicated that the assumption of homogeneity of variances was violated ($p < .05$). Therefore, Welch's independent-samples t-test was used, and the results are reported based on the equal variances not assumed output. The results of Welch's independent-samples t-test revealed a statistically significant difference between the post-test mathematics achievement scores of the experimental and control groups. As shown in Table 1, the experimental group achieved significantly higher post-test mathematics achievement scores than the control group, indicating the positive effect of the social media-supported instruction. According to Cohen (1988), the effect size was very large (Cohen's d = 1.87), indicating that the social media-supported instructional intervention had a substantial positive effect on students' mathematics achievement.

Technology-Based Self-Directed Learning Skills

The second research question examined whether social media-supported mathematics instruction influenced students' technology-based self-directed learning skills. The Mann–Whitney U test revealed no statistically significant difference between the post-test scores of the experimental and control groups ($U = 364.50$, $Z = -0.648$, $p = .517$). Although the experimental group obtained a slightly higher mean rank than the control group, this difference was not statistically significant. Therefore, the findings do not provide sufficient evidence that this instructional intervention improved students' technology-based self-directed learning skills during the implementation period.

Table 2. Mann-Whitney U Test Results Regarding Post-test Scores of Experimental and Control Groups

Group	N	Rank Average	U	Z	p	Effect size (r)
Control	27	27.50	364.50	-.648	.517	.09
Experimental	31	30.35				

As shown in Table 2, the post-test self-directed learning readiness scores of the experimental and control groups were compared using the Mann–Whitney U test. The results indicated no statistically significant difference between the two groups, suggesting that they were comparable prior to the implementation. The effect size for the Mann–Whitney U test was also calculated ($r = .09$), indicating a negligible effect. This finding is consistent with the absence of a statistically significant difference between the experimental and control groups.

DISCUSSION, CONCLUSION, and RECOMMENDATIONS

Mathematics Achievement

The findings of this study revealed that social media-supported mathematics instruction significantly improved sixth-grade students' mathematics achievement compared with conventional instruction. This finding suggests that integrating social media into mathematics education can create learning opportunities that extend beyond classroom instruction and support students' academic development.

One possible explanation for this finding is that social media enabled students to access instructional resources repeatedly and independently outside regular lesson hours. Unlike conventional classroom instruction, this learning environment provided continuous access to instructional videos, digital learning materials, teacher guidance, and practice activities. Such opportunities may have allowed students to revisit mathematical concepts whenever necessary, reinforce previously learned content, and learn at their own pace. Consequently, the instructional process was not restricted to classroom time but continued throughout the learning period.

The present finding is consistent with previous studies reporting that technology-supported mathematics instruction contributes positively to students' mathematics achievement. Recent research has shown that well-designed digital learning environments can improve conceptual understanding, problem-solving performance, and academic achievement by providing flexible access to learning resources and increasing students' opportunities for practice and interaction (Sorochka & Zambak, 2024; Cinco et al., 2025). Rather than the technology itself, these studies emphasize that the instructional design underlying technology integration plays a decisive role in improving learning outcomes.

Taken together, these findings suggest that the positive effect observed on mathematics achievement may not simply be attributed to students' use of social media. Instead, it appears that social media functioned as a structured instructional environment where learning materials, teacher support, and learning activities were systematically organized to reinforce classroom instruction. Therefore, the findings suggest that social media can effectively support mathematics learning when integrated into instruction through purposeful pedagogical planning.

Technology-Based Self-Directed Learning Skills

Unlike mathematics achievement, the present study did not reveal a statistically significant difference between the experimental and control groups regarding technology-based self-directed learning skills. Although students who participated in the social media-supported learning environment demonstrated slightly higher post-test mean ranks, this difference was not statistically significant. Therefore, the findings suggest that the instructional intervention alone was not sufficient to produce measurable improvements in students' technology-based self-directed learning skills.

Although several previous studies have reported positive effect of technology-supported learning environments on students' self-directed learning skills (Melgaard et al.,2022; Sorochka & Zambak, 2024; Cinco et al., 2025), the present study did not reveal a statistically significant difference. These contrasting findings may be associated with differences in intervention duration, instructional design, participant characteristics, or the developmental nature of self-directed learning. Therefore, the findings suggest that improving students' self-directed learning skills may require more comprehensive and sustained instructional support than was provided in the present study.

One possible explanation is that self-directed learning is a complex competency that develops gradually through continuous learning experiences rather than through relatively short-term instructional interventions. Although students in the experimental group were provided with opportunities to access instructional materials outside classroom hours, communicate with the teacher, and review mathematical concepts repeatedly, the approximately seven-week implementation period may not have been long enough for significant changes in self-directed learning behaviors to emerge. Similar arguments have been proposed in studies emphasizing that self-directed learning develops progressively through sustained educational experiences (Knowles, 1975; Garrison, 1997; Grow, 1991).

Another possible explanation concerns the nature of the intervention. The instructional design primarily aimed to improve mathematics learning and academic achievement by extending learning opportunities through social media rather than explicitly teaching self-regulation or self-directed learning strategies. Previous research has suggested that improvements in self-directed learning generally require explicit instructional support, opportunities for reflection, goal-setting activities, and continuous monitoring of learning processes (Zimmerman, 2001; Pintrich, 2005).

Although the findings did not demonstrate statistically significant improvements in technology-based self-directed learning skills, this does not necessarily imply that social media has no educational value in supporting independent learning. Instead, the results indicate that simply incorporating social media into mathematics instruction may not be sufficient to strengthen students' self-directed learning competencies. More comprehensive instructional designs that intentionally integrate self-regulation strategies and provide longer implementation periods may be required to achieve measurable improvements.

These findings contribute to the literature by showing that the educational benefits of social media may differ depending on the learning outcome being examined. While this instructional approach appears to positively influence mathematics achievement, its effects on technology-based self-directed learning may require additional pedagogical support and longer-term implementation before statistically significant improvements can be observed.

Contribution to Literature

The present study contributes to the growing body of literature on technology-supported mathematics education by providing evidence that social media-supported mathematics instruction can significantly improve students' mathematics achievement. At the same time, the findings indicate that such instructional practices may not be sufficient to produce statistically significant improvements in technology-based self-directed learning skills over a relatively short implementation period. This

distinction highlights the importance of considering different educational outcomes separately when evaluating the effectiveness of the learning environments.

Limitations

Several limitations of this study should be acknowledged. First, the study was conducted with 58 sixth-grade students from a single public middle school in İstanbul, Türkiye, limiting the generalizability of the findings. Second, the intervention lasted approximately seven weeks. Although significant improvements were observed in mathematics achievement, no statistically significant differences were found in technology-based self-directed learning skills. Longer intervention periods may produce different outcomes regarding students' independent learning competencies. Finally, the study relied primarily on quantitative data. Future studies employing qualitative or mixed-methods approaches may provide deeper insights into how students experience social media-supported learning environments and how these environments influence the development of self-directed learning over time.

Another limitation of the study is that students in the experimental group received additional digital learning materials and online instructional support as part of the intervention. Being aware of their participation in a special instructional program may have influenced their motivation or engagement. Therefore, the possible influence of the Hawthorne effect cannot be completely ruled out when interpreting the findings.

Conclusion

This study investigated the effects of social media-supported mathematics instruction on sixth-grade students' mathematics achievement and technology-based self-directed learning skills. The findings demonstrated that students who participated in this instructional process achieved significantly higher mathematics achievement than those receiving conventional mathematics instruction. These findings suggest that systematically integrating social media into mathematics education can effectively support students' academic learning when implemented through carefully planned pedagogical practices.

However, no statistically significant improvement was observed in students' technology-based self-directed learning skills. This finding suggests that although social media can enrich mathematics instruction by extending learning opportunities beyond classroom hours, its integration alone may not be sufficient to strengthen students' independent learning competencies. The development of self-directed learning skills may require longer instructional interventions together with explicit support for self-regulation, goal setting, and reflective learning practices.

From a practical perspective, mathematics teachers may consider using social media as a complementary instructional environment to reinforce classroom learning and improve students' mathematics achievement. Future research should investigate whether longer implementation periods, different instructional designs, or explicit self-directed learning strategies enhance the effectiveness of social media-supported mathematics instruction in fostering independent learning skills.

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