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Author for correspondence:
Ahmad Fauzan
e-mail: ahmadfauzan@fmipa.unp.ac.id

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Middle School Teachers' Professionalism, Beliefs, and Attitudes on Technology Integration: Implementing Scratch in Coding-Based Mathematics Learning

Ahmad Fauzan[1], Ika Parma Dewi[1], Rio Anshari[1], Yulyanti Harisman[1], Fridgo Tasman[1,2], Hafizatunnisa[1], and Pipin Sumarni[1]

[1] Universitas Negeri Padang, Indonesia
[2] Phd Students in Mathematics Education, Syracuse University, New York, Amerika Serikat

Abstract- This study addresses the challenge of limited teacher readiness in integrating digital technology into mathematics instruction, particularly through coding-based learning media. It focuses on teacher professionalism by examining their attitudes and beliefs toward the use of Scratch as a tool for developing interactive and contextual mathematics teaching materials. A survey design was employed with twenty junior high school teachers in Bukittinggi City who had previously participated in intensive training on the development of Scratch-based materials. Data were collected using questionnaires, structured interviews, and classroom observations, which served as the main research instruments. The findings reveal that 92% of teachers hold positive beliefs about the integration of digital culture–based technology through Scratch, and 88% perceive it as beneficial for students' learning. Furthermore, 89% of teachers showed strong engagement and active participation throughout the activities. These results highlight the potential of Scratch to strengthen teachers' technological pedagogical competence, provide students with more engaging learning experiences, and offer valuable insights for further research on technology-enhanced mathematics education.

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1. Introduction

Digital technology has become an integral part of educational transformation in the modern era. Its presence offers new opportunities for developing teaching materials that are more dynamic, interactive, and aligned with the characteristics of today's digital generation (Varol, 2015; Xu et al., 2022). Technology enables educators not only to deliver content in a conventional manner but also to create more engaging and meaningful learning experiences through visual media, simulations, and simple programming-based applications (Hikmatila & Armiati, 2020; Syahdan & Abadi, 2018). The integration of technology into teaching materials strongly supports efforts to enhance learning quality, particularly in fostering students' active participation and in developing critical and creative thinking skills (Altmeyer et al., 2020; Chang et al., 2021; Pradana et al., 2020).

Nevertheless, the implementation of technology in classroom practice often encounters challenges at the practitioner level, particularly among teachers. Not all teachers demonstrate the same readiness to adopt and utilize technology, whether due to limited digital skills or personal attitudes toward change (Harisman, Kusumah, Kusnandi, et al., 2019; Harisman et al., 2023; Heitink et al., 2016). Some teachers still perceive technology use as an additional burden rather than as a supportive tool that can facilitate their work (Nasution et al., 2024). Teachers' acceptance of technology is significantly influenced by their beliefs in its effectiveness in the teaching–learning process, as well as by their attitudes toward educational change and innovation (Farjon et al., 2019; Reinhold et al., 2021).

In the context of mathematics learning, technology-based media plays a crucial role in facilitating the understanding of abstract concepts. Applications such as Scratch, which is designed to introduce visual programming in a simple manner, enable teachers to create teaching materials that incorporate animation, simulation, and interactivity (Molina-Ayuso et al., 2022; Rodríguez-Martínez et al., 2020). With Scratch, mathematical concepts can be represented in visual and logical forms that are manipulable, such as in the design of educational games or computational simulations (Daher et al., 2020; Dohn, 2020; Maulana et al., 2023; Olsson & Granberg, 2024). This opens significant opportunities for mathematics teachers to enhance both instructional effectiveness and student engagement, particularly in mastering complex concepts (Olsson & Granberg, 2024).

One of the key aspects determining the successful integration of technologies such as Scratch into instruction is teacher professionalism, particularly in terms of their beliefs and attitudes toward technology (Harisman et al., 2022, 2023; Harisman, Kusumah, & Kusnandi, 2019; Harisman, Kusumah, Kusnandi, et al., 2019; Nasution et al., 2024; Subhan et al., 2020). Teachers who believe that technology can enhance instructional quality are generally more open and motivated to adopt it (Nasution et al., 2024). Conversely, those who remain hesitant or reluctant to engage with technology tend to persist with conventional approaches, even when technological tools are available (Nasution et al., 2024). Understanding teachers' attitudes and beliefs is therefore a critical factor in designing effective and sustainable professional development programs (Nasution et al., 2024).

While numerous studies have explored the integration of technology in education and the factors influencing teachers' adoption, few have specifically examined how mathematics teachers at the junior high school level perceive the use of programming applications such as Scratch for developing teaching materials. Scratch, which is free, block-based, and beginner-friendly, holds considerable potential as a teaching aid, yet its use in mathematics education remains underexplored (Maulana et al., 2023; Olsson & Granberg, 2024). This study seeks to fill this gap by providing new insights into teachers' beliefs and attitudes toward Scratch as an element of their professionalism in responding to the challenges of 21st-century education.

Research on teacher professionalism in integrating technology into instruction has indeed gained considerable attention. Harisman et al. (2023) reported that mathematics teachers expressed positive attitudes toward the use of e-comics as a learning medium, as they were perceived to enhance students'

interest and motivation in learning mathematics. Similarly, Nasution et al. (2024) found that teachers considered ClassPoint an effective tool for improving instructional quality while simultaneously capturing students' attention. In line with these findings, the present study aims to analyze the role of teachers' beliefs and attitudes in adopting technology, with a particular focus on Scratch as an innovative approach to mathematics learning. Moreover, this research is expected to provide a conceptual foundation for designing more contextual and targeted teacher training programs in the future.

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2. Methods

This study employed a survey approach to examine the professionalism of junior high school (SMP) teachers in Bukittinggi City in integrating technology, with a particular focus on the use of Scratch for developing coding-based mathematics teaching materials. The participants consisted of mathematics teachers who were members of the Junior High School Mathematics Teacher Working Group (MGMP) in Bukittinggi. The research activities began with a four-day intensive training program that focused on utilizing various Scratch features to design interactive teaching materials aligned with curriculum requirements. Following the training, teachers were given the opportunity to independently develop their own coding-based teaching materials using Scratch as a learning medium. To measure their perceptions, the survey instrument was designed to assess two main aspects: beliefs and attitudes toward the use of technology in the teaching–learning process. In addition, in-depth interviews were conducted with selected teachers to explore their experiences and the challenges they faced during the development of teaching materials. The study also monitored the level of teacher engagement and participation throughout the research activities. The instruments used for data collection are summarized in Table 1.

Table 1. Data Collection Instruments

Assessment Aspect	Instruments
Teachers' Beliefs	Questionnaire, Interview
Teachers' attitudes	Questionnaire

Source: Harisman et al. (2022)

The indicators used to assess teachers' beliefs in integrating technology into instruction are presented in Table 2.

Table 2. Indicators of Teachers' Belief Questionnaire

No	Aspects of teacher beliefs
a	Teachers' beliefs about the role of technology in the teaching–learning process.
b	Teachers' beliefs about students' engagement when technology is integrated into instruction.
c	Teachers' beliefs about their own knowledge of integrating technology into instruction.

Source: Harisman et al. (2022)

Statements measuring teachers' attitudes toward technology were included in the questionnaire, as shown in Table 3.

Table 3. Sample Statements from the Teachers' Attitude Questionnaire

No	Example Statements from the Attitude Questionnaire
a	Training using the Scratch application is a new experience for me.
b	I am very interested in the ClassPoint application after it was explained by the trainer.
c	I only talked or chatted while the trainer was explaining Scratch.
d	I frequently asked the trainer questions whenever I did not understand a certain Scratch feature.
e	I could not follow the instructions in the training module provided during this activity.
f	I will use this application to help my students solve problems when needed.

Source: Subhan et al. (2020)

Questionnaire data were processed using percentage calculations, where the obtained scores were

compared with the maximum score and then converted into percentages. Additional data were obtained through interviews with teachers, with several example questions presented in Table 4.

Table 4. Sample Interview Questions

No	Sample Interview Questions
a	To what extent do you consider digital culture as a competency that teachers must possess today?
b	To what extent do you believe that digital culture in teaching material development can be trained and continuously improved?
c	In your opinion, should coding-based mathematics teaching materials using Scratch, within the TPACK framework, be considered an essential competency for teachers?
d	To what extent do you believe that technology-integrated teaching materials foster students' critical and systematic thinking skills?

Source: modified from Harisman et al. (2023)

3. Results and Discussion

The questionnaire data were analyzed using a simple percentage method, in which the total score was divided by the maximum possible score and then multiplied by 100%. The detailed results of teachers' beliefs and attitudes toward the use of technology are presented in Tables 5 and Table 6.

Table 5. Analysis of Teacher Belief Questionnaire Results

No	Questionnaire Statement	Aspect	Percentage of total score divided by maximum score
1	Statement 1	Technological Culture Produces Teaching Materials	98%
2	Statement 2	Technological Culture Produces Teaching Materials	92%
3	Statement 3	Technological Culture Produces Teaching Materials	92%
4	Statement 4	Technological Culture Produces Teaching Materials	96%
5	Statement 5	Technological Culture Produces Teaching Materials	86%
6	Statement 6	Technological Culture Produces Teaching Materials	88%
7	Statement 7	Benefits of Teaching Materials for Students	85%
8	Statement 8	Benefits of Teaching Materials for Students	87%
9	Statement 9	Benefits of Teaching Materials for Students	91%

The analysis in Table 5 shows a percentage of 92% for the dimension of digital culture in teaching material development, and 88% for the aspect of perceived benefits for students. These findings indicate that teachers' beliefs regarding the integration of technology—particularly the use of Scratch in designing coding-based mathematics materials—fall within the high category.

Table 6. Analysis of Teacher Attitude Questionnaire Results

No	Questionnaire Statement	Indicator	Percentage of total score divided by maximum score
1	Statement 1	Attention	92%
2	Statement 2	Attention	94%
3	Statement 3	Attention	91%
4	Statement 4	Attention	84%
5	Statement 5	Attention	84%

No	Questionnaire Statement	Indicator	Percentage of total score divided by maximum score
6	Statement 6	Participation	82%
7	Statement 7	Participation	76%
8	Statement 8	Attention	92%
9	Statement 9	Participation	91%
10	Statement 10	Participation	89%
11	Statement 11	Participation	89%
12	Statement 12	Participation	100%
13	Statement 13	Attention	85%
14	Statement 14	Attention	87%
15	Statement 15	Participation	93%
16	Statement 16	Participation	89%

The analysis in Table 6 demonstrates identical results of 89% for both the indicators of attention and participation. This suggests that teachers' attentiveness and active involvement in integrating technology, particularly during Scratch training for mathematics material development, can also be categorized as high.

Further insights were obtained from interviews with three teachers. One teacher highlighted the challenges of adapting to new technologies, especially for senior teachers, noting:

Researcher : *In your view, to what degree should digital culture be regarded as a required competency for teachers in the current educational era?*

Teacher : *I consider digital culture to be important; however, for teachers who have been teaching for a long time, adaptation can be quite challenging. There are limitations in mastering new applications, which makes continuous support necessary. Therefore, in my view, digital culture is indeed a mandatory competency, but both the government and schools must facilitate training so that all teachers can keep up with developments effectively.*

The interview findings confirm that teachers regard technological proficiency as a fundamental competency that must be possessed. In addition, several teachers provided comments related to training. A summary of their responses is presented in the following section.

Researcher : *To what extent do you believe that digital culture in the development of teaching materials can be trained and continuously developed?*

Teacher : *I believe that digital culture has already become part of a teacher's role. Today's students are very close to technology, and therefore teachers must also align themselves so that learning becomes more relevant and engaging. By mastering applications such as Scratch or other digital platforms, teachers can design lessons that are more creative, interactive, and connected to students' real-world contexts.*

Based on the survey and interview findings, it can be concluded that teachers demonstrate positive beliefs and attitudes toward the use of technology, particularly through Scratch in developing coding-based mathematics teaching materials. These findings strengthen previous studies emphasizing the importance of teachers' positive attitudes as a prerequisite for successful technology integration (Kerckaert et al., 2015; Palaiologou, 2016; Reinhold et al., 2021). The positive perspectives of junior high school teachers in Bukittinggi are consistent with Nasution et al. (2024), who reported that teachers perceived digital applications such as ClassPoint as effective tools for enhancing instructional quality and student engagement.

Moreover, the present findings confirm that teachers' confidence in technology facilitates the adoption of digital applications in classroom practice. This is in line with the conclusions of Ardıç (2021), Harisman et al. (2023), and Nasution et al. (2024), who found that positive teacher attitudes toward technology contribute significantly to the advancement of technological pedagogical competence. In this study, Scratch was perceived not merely as a teaching aid but also as a medium for fostering teachers' creativity in designing mathematics materials that are interactive, logic-based, and relevant to 21st-

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century learners' needs.

These findings also have important practical implications. First, teachers' positive attitudes toward Scratch may serve as a foundation for expanding the integration of coding into the mathematics curriculum, enabling students to acquire not only mathematical concepts but also computational thinking skills. Second, teachers' strong beliefs in the benefits of technology highlight the need for more contextual professional development programs that enhance teachers' competence in using coding applications. Thus, this study supports the view that teacher professionalism in leveraging technology plays a crucial role in creating innovative learning experiences that are aligned with the demands of the digital era.

4. Conclusion

The findings indicate that mathematics teachers at junior high schools in Bukittinggi hold positive beliefs and attitudes toward the use of technology, particularly the application of Scratch in developing coding-based mathematics teaching materials. Most teachers perceived Scratch not only as a valuable tool for creating interactive learning media but also as a means to enhance their creativity in designing contextual instructional resources while providing students with more engaging learning experiences. The high level of teacher confidence, involvement, and participation underscores that technology integration through Scratch can serve as an effective strategy to support mathematics learning innovation.

Nevertheless, this study has several limitations. First, the number of participants was confined to junior high school mathematics teachers within the Bukittinggi Teacher Working Group (MGMP), thus the findings cannot yet be generalized to other regions with different contexts. Second, the research instruments primarily emphasized teachers' beliefs and attitudes, while their technical skills in utilizing Scratch were not explored in depth.

The implications of this study highlight the importance of practice-based training focused on the use of coding applications such as Scratch to support mathematics instruction. Given teachers' positive attitudes and beliefs, training programs can be designed to be more contextual, sustainable, and aligned with field needs, thereby strengthening teachers' technological pedagogical competence.

For future research, it is recommended to expand the participant scope to include schools in other regions, particularly those with varying levels of technological access, in order to obtain a more comprehensive perspective. Furthermore, subsequent studies could also examine the direct impact of Scratch on student learning outcomes and computational thinking skills, thereby offering a more holistic understanding of the role of technology integration in mathematics education.

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