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Teachers' Beliefs and Attitudes Toward TPACK-Oriented Technology Integration for Quality Education: Developing Genial-Based Mathematics Learning Materials

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Abstract: This study examines the beliefs and attitudes of high school mathematics teachers toward TPACK-oriented technology integration through the development of interactive teaching materials using Genially in Pesisir Selatan Regency. TPACK orientation is positioned as the foundation for integrating technological knowledge and mathematical content knowledge in the development of digital teaching materials. The study used a survey method with twenty mathematics teachers as participants. Data were collected through belief questionnaires, attitude questionnaires, and structured interviews to explain the reasons behind the questionnaire responses. Belief indicators include teachers' views on learning and knowledge for learning related to technology engagement. Attitude indicators include familiarity, interest, efforts to seek help when experiencing difficulties with features, and the desire to use Genially to support students' mathematical problem-solving during learning. The results showed very high acceptance of the use of technology, especially the Genially application (94–95% agreement on key indicators). Interviews confirmed that Genially's visual interactivity helps teachers explain abstract concepts and relate the material to real-life contexts, but internet stability and initial design time remain obstacles. These findings support Quality Education (SDG 4) by strengthening teachers' readiness to integrate technology in mathematics learning.

Keywords: Genially; Mathematics learning material; Teacher attitude; Teacher belief; TPACK

Introduction

The advancement of digital technology has created broad opportunities in education, particularly in fostering innovation in instructional material development. Technology enables teachers to design learning media that are not only informative but also interactive and engaging (Chai, 2019; Sofendi et al., 2021; Xu et al., 2022). In the digital era, learning is no longer confined to blackboards and textbooks; rather, it can be expanded through a variety of digital applications that support visualization, simulation, and interactive presentation (Bito & Masaong, 2023; Pradana et al., 2020; Putra & Milenia, 2021). Such innovations hold significant potential to enhance students' motivation and comprehension of the subject matter, particularly in challenging subjects such as mathematics (Masero-Moreno, 2022; Makarim, 2023; Abadiyah, 2023).

However, technology integration into learning practices is not always evenly distributed. Not all teachers share the same readiness and interest in adopting technology in learning (Baek et al., 2018; Muralidharan et al., 2019; Ottenbreit-Leftwich et al., 2010). Frequent barriers include limited institutional

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support, unstable access and infrastructure, and the perception that technology is difficult to implement in certain subjects (Harisman et al., 2022a; Harisman et al., 2023; Harisman et al., 2019a; Harisman et al., 2022b; Nasution et al., 2024; Subhan et al., 2020). In this context, teachers' beliefs and attitudes are key factors because they influence their decisions to accept, try, and integrate technology into learning (Beswick, 2007; Farjon et al., 2019; Reinhold et al., 2021).

A frequently used framework to explain technology integration by teachers is TPACK (Technological Pedagogical Content Knowledge), which is the knowledge teachers need to meaningfully integrate technology with content and learning (Fitriyah et al., 2024; Halim et al., 2024; Zikriana et al., 2023). In this study, TPACK is seen as relevant primarily as a framework for integration readiness: teachers' beliefs about the benefits of technology and its role in mathematics learning, as well as their attitudes toward technology use, influence their willingness to develop and use digital media aligned with mathematics content (Hardi, 2023; Sama et al., 2023; Wulandari et al., 2025). In other words, beliefs and attitudes function as psychological factors that support or hinder the actualization of TPACK in technology integration practices in the classroom (Beswick, 2007; Farjon et al., 2019; Reinhold et al., 2021).

In high school mathematics, the need for digital media is more specific than in many other subjects. Students often struggle when concepts require dynamic visualization and relationships between representations (Pantiwati et al., 2024). For examples, in spatial geometry and transformations, functions and graph interpretation, or limits and derivatives, which require an understanding of change (Makarim, 2023; Hernández et al., 2024; Plummer et al., 2022; Abadiyah, 2023; Supli & Yan, 2024). Interactive media helps students see the relationships between symbolic, visual, and numerical representations more clearly, potentially enhancing conceptual understanding and learning engagement (Sakdiah et al., 2023; Susanti et al., 2025).

One application that can be utilized for these needs is Genially. This platform enables teachers to design digital teaching materials in the form of interactive presentations, quizzes, infographics, and visualizations that can be enriched with nonlinear navigation, immediate feedback, and interactive elements for concept exploration. Genially is relevant for mathematics because it can support activities that require manipulation and exploration, for example through interactive elements that guide students through the steps of understanding concepts, testing conjectures, and checking results independently (Makarim, 2023; Hernández et al., 2024; Abadiyah, 2023).

However, the success of implementing applications such as Genially is highly influenced by teachers' professionalism in responding to technology. Teachers with strong beliefs in the benefits of technology tend to be more open to innovation and more willing to experiment with new instructional approaches (Chan, 2022; Nicolaou et al., 2019; Weng et al., 2023; Wahyuni et al., 2021). Conversely, negative attitudes or reluctance toward change often discourage teachers from integrating technology into their teaching practices (Chan, 2022; Nicolaou et al., 2019; Weng et al., 2023; Wahyuni et al., 2021). Therefore, examining teachers' beliefs and attitudes is essential for understanding their readiness to address the challenges of 21st-century learning (Beswick, 2007; Farjon et al., 2019; Reinhold et al., 2021).

Several previous studies have emphasized the role of teacher beliefs and attitudes in the adoption of educational technology. However, discussions regarding Genially as a tool for developing mathematics teaching materials that emphasize concept exploration still require further development. For instance, Harisman et al. (2023) reported that mathematics teachers exhibited positive attitudes toward creating mathematics e-comics as learning tools. Teachers believed that mathematics e-comics could enhance students' interest and motivation in learning mathematics (Harisman et al., 2023). Similarly, Nasution et al. (2024) found that teachers believed Class Point could improve instructional quality and foster greater student interest. While e-comics are effective for motivation, Genially offers advantages in concept exploration through drag-and-drop features and gamification, which were not explored in the study by Harisman et al. (2023). Furthermore, compared to interactive presentation-based media that primarily emphasize class responses, Genially provides more space for exploration-based learning activities that can be designed as a flow of digital teaching materials (Hernández et al., 2024). Therefore, it is important to examine how teachers' beliefs and attitudes influence their acceptance and readiness to utilize Genially for technology integration in mathematics learning.

Therefore, this study aims to analyze high school mathematics teachers' beliefs and attitudes toward technology integration in mathematics learning through the use of Genially, using TPACK as a conceptual framework for understanding technology integration aligned with mathematics content. The research findings are expected to contribute to the understanding of psychological factors (beliefs and attitudes) that support teachers' readiness for technology integration, while also providing implications for the development of more interactive and meaningful digital mathematics teaching materials.

Method

This study uses a descriptive survey design supported by qualitative data (interviews) to describe the beliefs and attitudes of high school mathematics teachers towards the acceptance of technology use (Genially) in developing mathematics teaching materials. The TPACK framework is used as a conceptual foundation to position technology acceptance as part of teachers' readiness to integrate technological knowledge with mathematics content in the form of digital teaching materials.

The study participants were 20 high school mathematics teachers who were members of one MGMP group. The selection of participants used purposive sampling, based on affordability and accessibility, taking into account the geographical conditions of schools spread across coastal and semi-rural areas, which affect teacher mobility and coordination. The participants' teaching experience varied across categories of < 10 years, 10–20 years, and > 20 years, thus representing a diverse range of professional experience within the MGMP context.

This research process began with establishing the research objective, namely mapping the beliefs and attitudes of high school mathematics teachers towards the acceptance of technology use (Genially) for the development of TPACK-oriented mathematics teaching materials. Next, the researcher determined participants using purposive sampling based on affordability and accessibility in the research area. After determining the participants, the researcher prepared a research instrument adapted from previous relevant studies on teacher beliefs, attitudes, and technology integration in mathematics learning (Harisman et al., 2023; Harisman et al., 2019b; Nasution et al., 2024). The instrument was then reviewed to ensure the suitability of the indicators with the context of Genially's use and the research focus (belief and attitude), for example through expert judgment and/or a limited readability test. The next stage was quantitative data collection, in which all participants completed belief and attitude questionnaires. The research flowchart can be seen in Figure 1.

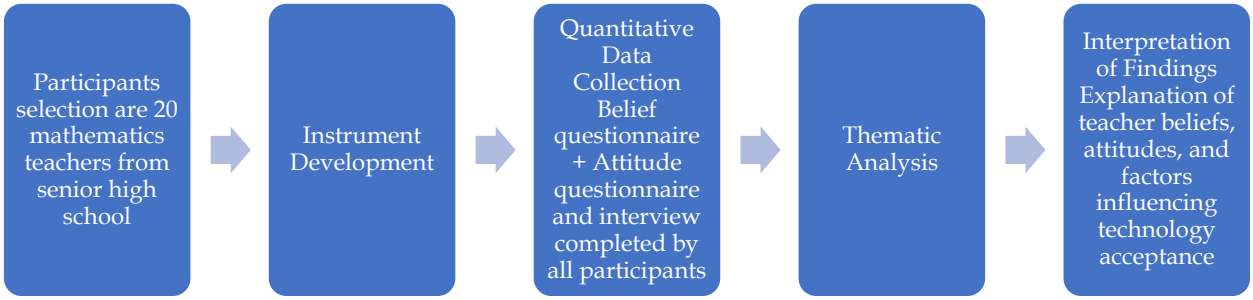

Figure 1. Research flowchart

After the questionnaire data were collected, the researcher selected several teachers as informants for targeted interviews (for example, based on variations in questionnaire responses) to obtain a more in-depth explanation of the reasons, experiences, and supporting and inhibiting factors for technology acceptance. Table 1 presents the assessment indicators related to teachers' beliefs about the use of technology in teaching.

Table 1. Teacher belief questionnaire indicators

Aspect of Teacher Beliefs
Teacher beliefs about learning and the involvement of technology in learning.
Teacher beliefs about students' learning and the involvement of technology in teaching.
Teacher beliefs about knowledge for learning and the involvement of technology in learning.

Source: Harisman et al. (2022a)

Table 2 displays the questionnaire items that measure teachers' attitudes toward the use of technology.

Table 2. Questions on the teacher attitude questionnaire

Example Statements from the Attitude Questionnaire
Genially is new to me.
I was very interested in the Genially app after the speaker explained it.
I will use this app to help my students solve problems when needed.

Source: Subhan et al. (2020)

Additional data were obtained from teacher interviews, with sample questions presented in Table 3.

The research data were analyzed by combining descriptive quantitative analysis and qualitative analysis. The belief and attitude questionnaire data were

analyzed using percentage-based descriptive statistics, namely the obtained score divided by the maximum score and then multiplied by 100% to describe the level of teacher belief and attitude towards the acceptance of the use of Genially in developing mathematics teaching materials. The percentage results were then presented in the form of a summary of findings for each indicator to reveal the general trend of teacher responses. Meanwhile, interview data were analyzed thematically through the stages of transcription, coding, grouping codes into themes, and drawing interpretations. The emerging themes were used to explain the reasons behind the questionnaire responses, including factors that support and hinder technology acceptance. In the final stage, triangulation was conducted by comparing the questionnaire results and interview findings so that interpretations regarding teacher beliefs and attitudes towards TPACK-oriented technology integration became stronger and more contextual.

Table 3. Example of interview questions

Example of Interview Questions
To what extent do you consider technological culture a necessary competency for today's teachers?
To what extent do you believe that technological culture in the creation of teaching materials can be trained and continuously developed?
Do you believe that using TPACK-based teaching materials using the Genially application to create mathematics teaching materials is a competency that educators must possess?
To what extent do you believe that teaching materials that utilize technology play a role in fostering students' critical and systematic thinking skills?

Source: modified from Harisman et al. (2023)

Result and Discussion

The questionnaire results indicate that teachers' belief in the use of technology to develop mathematics teaching materials is in the very high category. Percentage scores for the confidence indicator ranged from 88% to 100%. The highest score occurred for a statement emphasizing the importance of technological culture in producing teaching materials, while the lowest score occurred for a statement related to aspects of technological culture (88%). Overall, these findings indicate that teachers view the use of Genially technology as relevant to supporting the development of mathematics teaching materials. The results of the teacher belief questionnaire analysis can be seen in Table 4.

In the attitude questionnaire, percentage scores ranged from 84 to 99%. The attention and participation indicators showed high scores, but several items had relatively lower scores (e.g., 84 and 87%), indicating variations in teachers' comfort and involvement with technology use. This variation is important to interpret alongside the interview data to understand factors that support and hinder technology adoption. The results of the teacher attitude questionnaire analysis can be seen in Table 5.

Table 4. Analysis of the results of the teacher belief questionnaire

Aspect	Score (%)
Technological Culture Produces Teaching Materials	100
Technological Culture Produces Teaching Materials	95
Technological Culture Produces Teaching Materials	91
Technological Culture Produces Teaching Materials	99
Technological Culture Produces Teaching Materials	88
Technological Culture Produces Teaching Materials	98
Benefits of Teaching Materials for Students	94
Benefits of Teaching Materials for Students	91
Benefits of Teaching Materials for Students	96

Table 5. Analysis of teacher attitude questionnaire results

Indicators	Score (%)
Attention	98
Attention	98
Attention	95
Attention	87
Attention	91
Participation	93
Participation	84
Attention	95
Participation	96
Participation	96
Participation	96
Participation	99
Attention	93
Attention	94
Participation	95
Participation	96

Interviews confirmed that teachers value technology as an important competency and view digital teaching materials as useful for presenting abstract mathematical concepts. However, the interviews also highlighted several challenges teachers faced, such as internet stability, limited time to prepare digital teaching materials, and differences in comfort with technology among teachers with varying teaching experience. These qualitative findings explain why, despite the high scores on beliefs and attitudes, some items still scored lower. As a follow-up, interviews were conducted with three teachers, with an example of one teacher's response presented below.

Researcher : To what extent do you consider technological culture a necessary competency for today's teachers?

Teacher : As a teacher, I believe that technological culture is a necessary competency for today's teachers because it plays a direct role in improving the quality of learning. The use of technology not only facilitates classroom management but also encourages teachers' creativity in designing more interactive learning, relevant to students' needs, and in line with the demands of the digital era.

Based on the interview results, teachers emphasized that technological proficiency is a mandatory competency. Several teachers also added reflections regarding their experiences in attending the training. A summary of the teachers' statements can be found in the following section.

Researcher : To what extent do you believe that a technological culture in teaching materials creation can be trained and continuously developed?

Teacher : In my opinion, a technological culture in teaching materials creation can be trained and continuously developed because digital skills are dynamic and adaptive. Teachers can improve their competencies through training, ongoing practice, and the use of various learning platforms. Therefore, technological mastery is not an innate ability, but rather a professional skill that can be developed to meet the needs of the times.

The findings obtained through questionnaires and interviews reveal that teachers hold strong beliefs and positive attitudes toward the use of technology in developing digital-based instructional materials. This condition indicates that technology is not merely viewed as a supplement, but rather as an essential component that supports instructional effectiveness. These findings are consistent with several previous studies (Hillmayr et al., 2020; Kerckaert et al., 2015; Palaiologou, 2016; Reinhold et al., 2021), which affirmed that the majority of educators—approximately 94%—perceive the use of computers in mathematics instruction as highly significant (Kerckaert et al., 2015; Palaiologou, 2016).

Another study conducted by Nasution et al. (2024) reported similar tendencies, demonstrating teachers' positive beliefs in technology, particularly in the development of teaching materials using the ClassPoint application. In line with this, previous research has shown that positive teacher attitudes toward technology facilitate the integration of digital media into everyday instructional practices (Harisman et al., 2023; Nasution et al., 2024; Subhan et al., 2020). Moreover, several studies have emphasized that such beliefs and attitudes significantly influence the enhancement of technology-based pedagogical competence (Ardıç, 2021; Harisman et al., 2023).

Conclusion

The results of this study indicate that high school mathematics teachers in Pesisir Selatan Regency have strong beliefs and positive attitudes toward the use of digital technology, particularly Genially, for developing mathematics teaching materials. High questionnaire scores (94–95% on the main indicators) indicate good acceptance, while interviews confirmed that Genially is perceived as helpful in presenting abstract mathematical concepts and facilitating the connection of material to real-life contexts. However, these findings also indicate that these positive attitudes do not automatically guarantee consistent technology integration, as teachers still face practical challenges such as internet stability and the time required to design digital open materials. In the context of coastal areas with dispersed schools, collaboration through MGMP has the potential to be an important supporting factor for sharing resources, aligning materials, and maintaining consistent implementation across schools. Overall, from a teacher perspective, Genially has potential as an alternative medium for developing mathematics teaching materials; however, further research is needed to test its classroom implementation and impact on student learning outcomes in a broader and more diverse sample. These findings imply that teachers' positive attitudes serve as a key factor in the successful implementation of educational technology. The use of Genially can be regarded as a strategic alternative to foster teacher creativity, strengthen digital pedagogical competence, and create more interactive and contextual learning experiences for students. Nevertheless, this study has limitations, as it only involved high school mathematics teachers in a single region, namely Pesisir Selatan Regency, and therefore the results cannot yet be generalized broadly. In addition, the survey approach did not fully capture the real classroom dynamics of teachers' practices. Future research is recommended to involve larger and more diverse samples, encompassing different educational levels and subject areas. Qualitative or mixed-method studies are also needed to provide deeper insights into teachers' experiences with technology integration. Furthermore, studies examining the effectiveness of Genially in improving student learning outcomes are required to more comprehensively measure its contribution to enhancing instructional quality.

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Author Contributions

There are several authors in this research articles. Conceptualization, methodology, F.D. and Y.H.; software, data curation, writing—original draft preparation, H.; validation, F.D., A.K.S., and H.; formal analysis, W.D.; investigation, P.S.; resources, M.L.N.; writing—review and editing, project administration, funding acquisition, F.D. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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