Al-Ishlah: Jurnal Pendidikan
Vol.17, 4 (December, 2025), pp. 8374-8386
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v17i4.8492

Integrating Powtoon Animation as a Digital Innovation for Enhancing Elementary Students' Mathematical Conceptual Understanding

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ARTICLE INFO

Keywords:

Powtoon;
digital learning media;
mathematics education;
primary school;
interactive animation

Article history:

Received 2025-08-19
Revised 2025-10-29
Accepted 2025-12-31

ABSTRACT

Mathematics instruction in elementary schools often presents challenges due to the abstract nature of concepts, especially in geometry. Digital innovations like animated media offer potential to enhance students' conceptual understanding and engagement. This qualitative case study explored the integration of Powtoon animation in teaching three-dimensional geometry to fifth-grade students at Palembang Integrated Islamic Elementary School. Data were collected through classroom observations, semi-structured interviews with teachers and administrators, and document analysis. The data were analyzed using Miles and Huberman's interactive model, involving data reduction, display, and conclusion drawing. Findings reveal that Powtoon enhanced students' conceptual understanding by providing dynamic visualizations, contextual illustrations, and simplified representations of complex ideas. The media supported student activeness, creativity, analytical thinking, and innovation. Teachers used Powtoon to deliver content in both structured and collaborative formats, tailored to classroom needs. Institutional factors—including principal leadership, infrastructure readiness, and teacher training—played a crucial role in supporting successful implementation. The study highlights the effectiveness of Powtoon in addressing pedagogical challenges in elementary mathematics. Its integration fosters student-centered learning and aligns with constructivist and multimedia learning theories. Positive student responses indicate increased motivation, participation, and cognitive engagement. The study also emphasizes the importance of school-wide support in sustaining digital innovations. Powtoon is a feasible and effective tool for improving mathematical conceptual understanding at the primary level. Future research should explore its broader application across diverse educational settings to validate these findings.

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1. INTRODUCTION

The rapid advancement of information and communication technology (ICT) has transformed educational practices, requiring teachers to integrate digital tools that make learning more effective and engaging (Alamsyah, 2023). In 21st-century education, technology integration is essential not only for improving learning outcomes but also for fostering critical thinking, creativity, collaboration, and digital literacy among students (Malay et al., 2025; Nursaya'bani et al., 2025). Within this context, the use of interactive digital media becomes crucial in subjects that are often perceived as abstract and difficult, such as mathematics in elementary schools.

Interactive digital media have been widely adopted to support students' active learning and conceptual understanding across various countries (Moore et al., 2021; Sung et al., 2016). Research shows that visual and interactive learning tools enhance students' motivation and comprehension by connecting abstract concepts to real experiences. In line with constructivist theory, students learn more effectively when they can explore and visualize knowledge through engaging multimedia environments (Mayer, 2021; Mifroh, 2020).

In the field of educational technology, learning media play a crucial role as intermediaries that help teachers communicate complex or abstract ideas in ways that are easier for students to grasp (Sadiman et al., 2014). Effective media are not merely visual aids, but carefully designed systems that combine text, images, animation, and sound to create meaningful learning experiences (Hamid et al., 2024). According to multimedia learning theory, the simultaneous use of verbal and visual channels enhances students' ability to integrate information and retain conceptual understanding (Mayer, 2021). Therefore, the success of technology integration in the classroom depends not only on the availability of digital tools, but also on how teachers design and utilize them to match students' cognitive and contextual needs. Within this framework, digital animation tools such as Powtoon represent an important innovation because they enable teachers to visualize mathematical ideas dynamically, support interactive learning, and connect abstract representations to real-world understanding.

Indonesia's current educational reforms, particularly the *Merdeka Belajar* (Independent Learning) policy, encourage teachers to adopt student-centered and technology-supported learning innovations (Tunas & Pangkey, 2024). However, the practical implementation of these policies in schools remains challenging. Many elementary teachers still struggle to design and operate digital learning media effectively, often relying on traditional lecture-based methods with limited visual support (Bentri et al., 2022; Rahmandani et al., 2025; Stefany & Helmi, 2024). This gap between policy and classroom practice highlights the need for more context-specific studies that explore how digital tools can be applied meaningfully in real classroom settings. In particular, subjects such as mathematics, where abstract and spatial reasoning are essential require instructional media that can visualize concepts interactively and concretely.

Mathematics learning in elementary schools often involves abstract and symbolic concepts that are difficult for students to visualize, especially in geometry topics such as three-dimensional shapes (Khasanah et al., 2019). Students frequently struggle to understand the relationship between two-dimensional nets and the three-dimensional objects they form, resulting in superficial conceptual understanding. According to multimedia learning theory, presenting information through both visual and verbal channels can significantly improve comprehension and retention (Meyer et al., 2014; Strømme & Mork, 2021; Teplá et al., 2022). Empirical evidence also shows that visual and animation-based media can help learners build stronger spatial reasoning and mental representations of geometric forms (Nguyen et al., 2020; Teplá et al., 2022). These findings indicate that effective visualization is essential for fostering conceptual understanding in geometry. Therefore, developing interactive media that can dynamically illustrate the transformation of geometric shapes—such as from nets to solids—is a key pedagogical need in elementary mathematics classrooms.

Preliminary observations at the research site revealed similar challenges in learning geometry. Many fifth-grade students struggled to understand the concept of three-dimensional figures, particularly in relating the shapes of two-dimensional nets to the solid forms they produce. Classroom

learning remained dominated by teacher-centered instruction using whiteboards and static illustrations, resulting in low student engagement and limited conceptual understanding. Interviews with teachers further indicated that digital learning media had not been utilized optimally, mainly due to limited technical skills and lack of confidence in designing interactive materials. These conditions underscore the need for innovative digital media that can present geometric concepts dynamically and make abstract mathematical ideas more accessible to young learners.

One digital medium with strong potential to address these learning challenges is **Powtoon**, an animation-based platform that enables teachers to create engaging videos integrating text, visuals, sound, and motion effects (Anjarsari et al., 2020; Komala et al., 2024). Its user-friendly design allows teachers to easily adapt materials to specific topics, including complex geometry concepts. Pedagogically, Powtoon aligns with Paivio's dual coding theory and Mayer's multimedia learning principles, which emphasize that learning is more effective when information is presented through coordinated verbal and visual channels. Through gradual motion and visual transitions, Powtoon helps students better visualize abstract processes, such as transforming two-dimensional nets into three-dimensional solids, thereby strengthening their spatial understanding and conceptual reasoning.

Previous studies have shown that Powtoon-based learning media can effectively enhance students' learning outcomes and motivation across various educational levels (Kusumawati et al., 2022; Suyanti et al., 2021; Yolanda & Laia, 2023). Most of these studies, however, were conducted in secondary school contexts and focused on general mathematics topics rather than geometry. Research specifically examining the use of Powtoon for teaching three-dimensional shapes in elementary schools remains scarce (Hamid et al., 2024; Rajagukguk, 2024). This gap indicates a need to investigate how Powtoon's interactive and visual features can support students' conceptual understanding and engagement in spatial learning. Therefore, the present study aims to explore the characteristics of Powtoon-based instruction in teaching solid figures to fifth-grade students and to analyze their responses toward its implementation.

This study is expected to contribute both theoretically and practically to the field of mathematics education. Theoretically, it enriches the existing literature on the integration of interactive digital media particularly animation-based tools such as Powtoon in elementary mathematics learning. Practically, the findings are anticipated to serve as a reference for teachers in selecting and designing digital learning materials that align with students' characteristics and cognitive needs. Specifically, this study aims to (1) describe the characteristics of Powtoon based instruction in teaching three-dimensional shapes, and (2) analyze students' responses to its implementation. Through these objectives, the study seeks to provide a comprehensive understanding of Powtoon's effectiveness as a digital learning medium in primary mathematics classrooms.

2. METHODS

This study adopts a qualitative case study design to explore how Powtoon-based learning media are implemented in teaching three-dimensional geometry to fifth-grade elementary students. The case study approach was chosen because it allows for an in-depth examination of the instructional process, media characteristics, and students' responses within a real classroom context (Creswell & Plano Clark, 2018). Data were collected through classroom observations, semi-structured interviews, and document analysis.

The research was conducted at Palembang Integrated Islamic Elementary School during the even semester of the 2024/2025 academic year. Participants were selected using a purposive sampling technique, considering their active involvement in Powtoon-assisted mathematics learning. The subjects included the principal, the head of facilities and infrastructure, and two fifth-grade mathematics teachers, Dewi (homeroom teacher of class VA, 28 students) and Hani (homeroom teacher of class VB, 29 students). In total, 57 fifth-grade students participated in this study. The case study

method was chosen to allow the researcher to understand the real context of digital media use in the classroom, along with students' and teachers' responses (Scott, 2018).

Data were collected through three techniques as suggested by (Winarni, 2018): (1) semi-structured interviews with principals, teachers, and students; (2) non-participant classroom observations during Powtoon-based learning in classes VA and VB; and (3) document analysis, including lesson plans, activity photos, student work, and video recordings of the learning process.

The research instruments were developed based on the study objectives and reviewed by two experts in educational technology to ensure content validity. Before formal data collection, a pilot test of the observation sheet and interview guide was conducted with a small group of teachers and students outside the sample to ensure the clarity and relevance of each item. Table 1 presents the summary of data collection techniques, instruments, and key indicators observed.

Table 1. Research Instruments

Data Collection Techniques	Instruments	Observed Indicators
Non-participant observations	Observation sheet	- Student activeness (asking, answering, discussing) - Creativity (design/illustration of building spaces) - Analytics (problem-solving skills) - Innovative (media development ideas)
Semi-structured interviews	Interview Guidelines	- Teachers' perceptions of Powtoon use - Students' experience when using Powtoon - School support for digital learning media
Documentation	Documentation format	- Student responses - Photos/recordings of the learning process

Data were analyzed using the interactive analysis model by Miles et al., (2018), which includes data reduction, data display, and conclusion drawing/verification. The process was conducted iteratively throughout the study to identify recurring patterns and emerging themes. To ensure data credibility, triangulation of data sources and methods was performed, along with member checking (confirming interpretations with participants) and peer debriefing with research colleagues. Ethical standards were maintained by obtaining informed consent from all participants, ensuring confidentiality, and using pseudonyms in all reports. This research also received ethical approval from the Institutional Review Board (IRB) of the State Islamic University Sunan Kalijaga, Yogyakarta.

3. FINDINGS AND DISCUSSION

3.1 Findings

This research produced key findings related to school support, learning facilities, teacher innovation, and student responses in the use of the Powtoon application in grade V mathematics learning. The results of the interviews are presented through direct quotations accompanied by the researchers' interpretation, then summarized in a table to facilitate understanding.

3.1.1 Theme 1 : The Role of the Principal

School principals play a pivotal role in fostering a culture that supports the integration of educational technology (Banoğlu et al., 2023). Their leadership determines how far teachers can innovate with digital media such as Powtoon. In an interview, the principal of Palembang Integrated Islamic Elementary School emphasized that technological competence is part of the school's vision and ongoing practice, stating that "technology is taught not only to students but also to teachers through regular digital media training."

This short statement reflects a visionary and adaptive leadership style that turns technology integration into a school-wide culture. Consistent with (Regar et al., 2025) and (Haryanti & Purbojo, 2024), such leadership directly contributes to shaping an institutional climate where teachers feel confident experimenting with new digital tools. At this school, the principal's initiatives—such as organizing workshops on Powtoon, providing digital facilities, and monitoring classroom implementation—translate policy discourse into concrete action.

In both Class VA and VB, teachers benefited from this supportive leadership. For example, the VA teacher showed stronger student participation during Powtoon-assisted lessons due to early involvement in digital media training, whereas the VB teacher emphasized creativity through project-based applications of Powtoon. This variation suggests that principal-driven programs not only provide facilities but also influence teachers' pedagogical orientation. Hence, adaptive and visionary leadership becomes the foundation for sustainable digital innovation in elementary mathematics learning.

3.1.2. Theme 2 : Infrastructure Support

Adequate facilities and infrastructure are crucial determinants of successful digital media integration in learning (Barrett et al., 2019). The research site demonstrated a strong institutional commitment to technology-based instruction by equipping classrooms with digital tools such as projectors, sound systems, and microphones. These facilities not only support instructional delivery but also encourage teachers to explore interactive applications like Powtoon.

During the interview, the head of facilities and infrastructure in February 2025 emphasized the school's proactive role in ensuring digital readiness, stating that "the school provides technologies such as projectors, sound systems, and microphones, and conducts training on applications and websites to help teachers design more engaging lessons". This statement reflects that the school's support goes beyond the mere provision of hardware—it also includes continuous professional development that strengthens teachers' confidence in using technology creatively.

In alignment with (Heinich et al., 2002), learning media can only function optimally when supported by adequate infrastructure. The institution's comprehensive approach, combining facility provision and training, thus creates an enabling ecosystem for innovative teaching practices. Comparative classroom observations further revealed how this infrastructure support translated into different instructional outcomes. In Class VA, Powtoon was integrated more smoothly because the teacher utilized school-provided projectors and sound systems effectively during demonstrations. Meanwhile, in Class VB, students showed greater independence, often volunteering to operate the equipment and assist peers in navigating digital tools. These variations suggest that access to infrastructure not only enhances teachers' instructional delivery but also cultivates students' digital competence and collaborative skills.

Consistent with (Raharjo et al., 2025), the readiness of facilities directly influences the effectiveness of digital learning media. When schools provide both the tools and the technical capacity to use them, innovation becomes sustainable rather than sporadic. Therefore, infrastructure support must be viewed as part of a broader pedagogical ecosystem, where digital tools, teacher competence, and institutional policy interact synergistically to improve the quality of mathematics learning through Powtoon.

3.1.3. Teacher Innovation

Teachers are the main implementers in implementing digital media-based learning innovations. The results of the study show that teachers choose Powtoon because they are able to answer the problem of low interest and student participation. This media is seen as able to provide the necessary variety in mathematics learning.

In an interview, Dewi, the mathematics teacher of Class VA, explained that the use of Powtoon originated from the need to address students' low participation, stating that "after I observed the students,

the problems found were a lack of interest, limited interactivity, and low student participation, which usually occurred because teachers were less varied in delivering material." Teachers consider that conventional learning makes students tend to be passive. By choosing Powtoon, teachers present media that are more communicative, interactive, and according to the characteristics of students.

Based on the results of interviews with school principals, heads of infrastructure, and mathematics teachers, it was found that the success of the use of Powtoon media could not be separated from the support of various parties. The principal provides policy direction and training, the head of infrastructure ensures the availability of technology facilities, and teachers are the direct implementers of learning innovations in the classroom. To make it easier to understand it thoroughly, a summary of the results of the interview is presented in Table 1 below.

Teachers serve as the primary agents in implementing digital media–based innovations. The findings indicate that both mathematics teachers in Classes VA and VB selected Powtoon as a strategic response to students' low engagement and limited interactivity. They viewed Powtoon as an effective medium to make mathematics learning more communicative, varied, and aligned with students' cognitive characteristics. During the interview, Dewi, the mathematics teacher of Class VA, explained her motivation for using Powtoon, stating that "*after observing my students, I found that their participation was low because teachers were less varied in delivering material.*"

Her statement reveals that Powtoon was introduced to address students' passivity and to promote interactive, visual learning experiences. The teacher recognized that conventional lecture methods and static textbooks did not sufficiently support conceptual understanding. Hence, integrating multimedia animations through Powtoon became a practical innovation to enhance student activeness. Similarly, Hani, the mathematics teacher of Class VB, emphasized the pedagogical strengths of Powtoon, stating that "*Powtoon provides clear concept visualization, contextual illustrations, interactivity, and systematic steps that simplify complex ideas*". Both teachers acknowledged that Powtoon not only facilitates conceptual comprehension but also encourages creativity and motivation. However, their instructional styles differed, reflecting the dynamic nature of classroom contexts.

Table 2 summarizes the triangulated insights gathered from the principal, head of facilities, and mathematics teachers, highlighting the systemic support that enables digital innovation.

Table 2. Summary of the Interview

Report	Key Statement	Researcher Interpretation
Principal	Technology-based private schools; Teachers receive regular training in the use of applications and digital media.	School culture supports technology integration, regular training equips teachers to be ready to innovate.
Head of Facilities	The school provides facilities (infocus, sound, mic); Application and Website Training for Teachers.	Sarpras is adequate to provide space for teachers to be creative, digital innovations are easier to apply in the classroom.
Math Teacher (VA & VB)	Students are passive during conventional learning; Powtoon was chosen because of its interactive & simple visuals.	Teachers take the initiative to present innovative media so that students are more active, creative, and understand concepts.

Before designing Powtoon-based lessons, both teachers conducted diagnostic observations to identify students' learning needs. Observation results showed that many students struggled to grasp geometric concepts when learning was dominated by teacher explanations and static illustrations. Consistent with constructivist theory (Ilham et al., 2023); (Setiyaningsih & Subrata, 2023), meaningful learning occurs when students can actively construct knowledge through interactive experiences. Powtoon's visual and multisensory features successfully brought these experiences into mathematics classrooms.

Comparative analysis revealed notable distinctions in how the two teachers implemented Powtoon. Class VA adopted a more structured approach, while Class VB emphasized creativity and collaboration. These differences are presented in Table 3.2.

Table 3. Cross-Case Comparison of Powtoon Implementation in Class VA and VB

Aspect	Class VA (Teacher: Dewi)	Class VB (Teacher: Hani)	Analytical Summary
Instructional Focus	Teacher-led demonstrations with Powtoon animations to strengthen conceptual understanding.	Student-centered projects where learners designed their own Powtoon-based visuals.	VA emphasized clarity and comprehension; VB emphasized autonomy and creativity.
Teaching Strategy	Structured explanation followed by guided practice.	Collaborative exploration and peer feedback activities.	Distinct strategies reflect adaptive use of the same medium to suit class dynamics.
Student Engagement	Active questioning and increased participation during problem-solving sessions.	High enthusiasm in media creation and presentation activities.	Both contexts fostered engagement, with VB showing higher initiative.
Infrastructure Use	Teacher operated projector and sound system for demonstrations.	Students helped manage devices and presentation flow.	Infrastructure contributed to both instructional delivery and digital literacy.

Table 3 demonstrates that while both classes benefited from Powtoon, their learning experiences diverged based on the teacher's pedagogical orientation. The structured approach in Class VA ensured conceptual clarity, whereas the creative project–based approach in Class VB nurtured autonomy and innovation. This comparison illustrates that teacher innovation is context-sensitive it depends not only on digital tools but also on how teachers adapt them to students' characteristics and classroom conditions.

Overall, the success of Powtoon integration was made possible by the synergy between institutional support and teacher creativity. The principal's policies, adequate infrastructure, and teacher initiative collectively shaped a sustainable model of digital learning innovation. This finding aligns with (Fullan, 2007) educational change theory, emphasizing that meaningful innovation arises from collaboration among all educational actors within the school ecosystem.

3.1.4. Student Response

Student responses are an important indicator of the success of digital media-based learning. The results of this study show that students respond positively to the use of Powtoon. They feel more enthusiastic, active, and understand the material better. The response of students to the use of Powtoon was very positive. As Dewi stated, students responded very positively to the use of Powtoon, explaining that "since we have used the Powtoon application, thank God students have become more active, creative, critical, and innovative; they actively ask questions, present, and understand material faster, as evidenced by the ever-increasing daily scores."

However, the observation results support this statement, it is found that students actively discuss, are more daring to present answers in front of the class, and propose to create their own version of Powtoon. According to the theory of learning motivation (Deci & Ryan, 1985), intrinsic motivation arises when students find learning interesting and relevant to their needs In addition to the relationship between the material and the characteristics of the media in the second table, this study also records changes in students' behavior and skills in more detail.

The second table presents four key aspects of activeness, creativity, analysis, and innovation identified through hands-on classroom observation and interviews with students.

Table 4. Student Responses

Observed Aspects	Indicators of Change	Field Evidence	Documentation
Activeness	Asking and answering more often, actively discussing	Students who were previously passive began to raise their hands to answer and give opinions	
Creativeness	Create a design or illustration of a building with a variety of colors and shapes	The students' work shows a richer variety of shapes and color combinations	
Analitis	Able to break down complex problems into small steps	Students re-explain the calculation process in front of the class in a sequence	
Innovative	Developing new ideas in the presentation of materials	Students propose creating their version of Powtoon for the next material	

The interpretation of the third table shows that the use of Powtoon not only has an impact on the understanding of concepts, but also changes the interaction patterns and ways of thinking of students. Activeness increases significantly, students' creativity is sharpened, and analytical skills develop through structured exercises. Emerging innovations, such as the desire to create their own learning media, show high emotional involvement in the learning process.

Communicative media bridges the teacher-student relationship, creating a more collaborative learning climate (Kurnia et al., 2025). The use of Powtoon also helps students who were previously passive become more engaged. This shows that digital media is able to reach various types of student learning. Overall, the positive student response confirms that Powtoon is effective not only in the cognitive aspect, but also in the affective and social aspects

3.2 Discussion

Based on the description above, it can be concluded that the success of using Powtoon is influenced by the synergy between institutional factors, facilities, teacher innovation, and student response. These four factors complement and reinforce each other. The principal as a leader provides policy direction and ensures that teachers have technological competence through training. The infrastructure sector provides tools that support the implementation of digital media. Teachers become creative implementers in arranging learning using Powtoon. Meanwhile, students gave a positive response which indicates that learning took place effectively. This synergy shows that learning innovation cannot run optimally without comprehensive support from all school components. Education system theory emphasizes that schools are an interdependent ecosystem (Fullan, 2007). Thus, each component has a complementary contribution.

The findings of this study reinforce the theory, that media innovation is not only limited to teacher choice, but is the result of a collective process. The results of other studies also show that school collaboration in developing digital media improves the quality of learning at the elementary level (Ridwana et al., 2022). With comprehensive support, the use of Powtoon is able to increase student engagement, improve the learning process, and encourage the achievement of curriculum goals. This synthesis emphasizes that the role of school principals, infrastructure support, teacher innovation, and student responses are an inseparable unit in realizing more effective mathematics learning in elementary schools.

Practically, this study provides an idea that the success of digital learning media can be replicated in other schools by ensuring synergy between educational actors. This is important to answer the challenges of the digital era in primary education (Liu et al., 2023). Thus, this discussion emphasizes that the integration of technology in learning is the result of collective work involving all parties in the school. Powtoon's success is clear evidence that this synergy has a positive impact on the quality of learning.

The results of this study show that the success of Powtoon-based learning in mathematics is not an isolated phenomenon but a product of interrelated factors within the school ecosystem. The findings illustrate that the principal's leadership, the readiness of facilities and infrastructure, the creativity of teachers, and the active participation of students work together to form a complete and supportive system. This finding reinforces the perspective of education system theory, which views schools as interdependent subsystems that must collaborate to achieve learning goals (Fullan, 2007). The integration of Powtoon in mathematics learning therefore reflects a systemic innovation built upon shared responsibility and mutual reinforcement among all school components.

The role of the principal becomes a determining factor in shaping a school culture that supports technology-based learning. As (Banoğlu et al., 2023) emphasize, leadership has a central role in creating an atmosphere that encourages teachers to innovate. The results of this study confirm that the principal's policy direction, regular training, and continuous supervision have succeeded in building a culture of adaptation to technology. Such support has strengthened teachers' readiness to use Powtoon as an innovative learning medium. This finding aligns with research by (Haryanti & Purbojo, 2024) which stated that adaptive leadership in responding to technological developments significantly improves the quality of teaching and learning processes.

In addition to leadership, the readiness of school infrastructure also plays a critical role in supporting the use of digital media. Adequate facilities, such as projectors, sound systems, and internet access, enable teachers to create a dynamic and interactive learning environment. (Heinich et al., 2002) The results of this study confirm that such infrastructure encourages teachers to be more confident and creative in developing Powtoon-based learning. Consistent with the findings of (Raharjo et al., 2025), the success of digital learning media is strongly determined by the availability of supporting facilities and teacher competence in using them.

At the instructional level, teacher innovation becomes the bridge that connects infrastructure readiness with student learning outcomes. The mathematics teachers in Classes VA and VB demonstrated creative use of Powtoon to transform abstract concepts into more concrete, visual, and engaging learning experiences. This finding supports the constructivist learning theory (Ilham et al., 2023); (Setiyaningsih & Subrata, 2023), which emphasizes that effective learning occurs when students are actively involved in constructing their own understanding. Through visual animation, sound, and narration, Powtoon creates meaningful learning experiences that allow students to relate mathematical concepts to real-life contexts.

The comparative implementation between Classes VA and VB highlights differences in pedagogical orientation and classroom dynamics. In Class VA, Powtoon was utilized through teacher-led explanations to strengthen conceptual understanding, while in Class VB, it was used more collaboratively to encourage creativity and peer interaction. These variations indicate that the effectiveness of digital media depends on how teachers align its use with student characteristics and

classroom culture. Both approaches, however, show that the use of Powtoon successfully increases student engagement and understanding of mathematical material. These findings affirm that the role of teachers as learning designers is crucial in ensuring that digital media function optimally in the classroom.

At the student level, the use of Powtoon fosters positive attitudes toward learning. Students become more enthusiastic, active, and participatory when exposed to interactive and visually appealing media. The results of this study show that students respond positively to learning processes that utilize animation, color, and movement. This response indicates that Powtoon not only improves students' cognitive comprehension but also nurtures their motivation and confidence in learning mathematics. These findings are consistent with previous research (Imamah et al., 2024); (Hizam et al., 2021), which found that visual-based digital media can increase student attention, engagement, and conceptual understanding.

Overall, the findings of this study reinforce the idea that innovation in learning media must be viewed holistically. The integration of Powtoon in mathematics learning demonstrates that successful digital learning requires synergy between institutional support, infrastructure readiness, teacher competence, and student participation. This synthesis confirms the statement of (Ridwana et al., 2022) that collaboration among school components is the main determinant of successful learning innovation. Moreover, the presence of supportive school policies and facilities allows teachers to continuously develop and implement digital learning media aligned with curriculum objectives.

Although the findings of this study provide significant insights, several limitations should be acknowledged. This research was conducted only in one private elementary school and involved two mathematics classes, so the results may not represent all school contexts. Future research can involve multiple schools and a larger number of participants to strengthen generalizability. Despite this limitation, this study contributes both theoretically and practically. Theoretically, it strengthens the constructivist perspective by showing that interactive media like Powtoon facilitate active and meaningful learning. Practically, it provides an example for schools to enhance teacher competence, improve infrastructure, and build institutional collaboration in integrating digital media into learning. These implications show that technological innovation in education is not only about tools but about creating a sustainable culture of learning transformation.

4. CONCLUSION

This study concludes that integrating Powtoon as an animated digital medium effectively enhances elementary students' conceptual understanding of geometry by transforming abstract content into concrete, interactive experiences. The findings reinforce constructivist learning theory, highlighting the role of visual and participatory media in strengthening students' engagement, analytical thinking, and creativity.

Practically, Powtoon provides teachers with a feasible tool to diversify instructional strategies and design more student-centered mathematics lessons. For school leaders, the study underscores the need to institutionalize digital learning initiatives through training, infrastructure support, and collaborative supervision. For developers and policymakers, it calls for the continuous improvement of localized, user-friendly animation platforms that align with curriculum goals and teachers' pedagogical capacities. Future research is encouraged to examine the scalability of Powtoon integration across various subjects and school contexts to broaden the evidence base for digital innovation in primary education.

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