



The Effect of Powtoon-Assisted Discovery Learning on Students' Trigonometry Learning Outcomes

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Abstract

Low achievement in trigonometry remains a persistent challenge in secondary mathematics education, primarily due to teacher-centred instructional practices and the limited use of interactive learning media, which hinder students' conceptual understanding of abstract mathematical concepts. This study investigated the effectiveness of Powtoon-assisted Discovery Learning in improving students' trigonometry learning outcomes. A quasi-experimental design employing a pretest–posttest control group design was implemented with 68 tenth-grade students from SMAN 1 Gondangwetan, Indonesia, selected through cluster random sampling. The participants were assigned to an experimental class ($n = 36$) and a control class ($n = 32$). Data were collected using a validated and reliable essay test designed to measure students' conceptual understanding of trigonometry. The findings indicated that students who learned through Powtoon-assisted Discovery Learning achieved a moderate N-gain score (0.43), substantially higher than the control group's low N-gain score (0.06). Furthermore, an independent-samples t -test revealed a statistically significant difference between the two groups ($p = .001$). In conclusion, integrating Discovery Learning with Powtoon animation effectively enhances students' conceptual understanding and learning outcomes in trigonometry. The study highlights the potential of interactive digital media to support more engaging and meaningful mathematics instruction in secondary schools.

Keywords: Discovery Learning, Powtoon, Trigonometry, Learning Outcomes, Conceptual Understanding

Abstrak

Rendahnya hasil belajar trigonometri masih menjadi tantangan dalam pembelajaran matematika di sekolah menengah, yang terutama disebabkan oleh praktik pembelajaran yang berpusat pada guru serta terbatasnya penggunaan media pembelajaran interaktif, sehingga menghambat pemahaman konseptual siswa terhadap konsep-konsep matematika yang bersifat abstrak. Penelitian ini bertujuan untuk mengkaji efektivitas model Discovery Learning berbantuan Powtoon dalam meningkatkan hasil belajar trigonometri siswa. Penelitian menggunakan pendekatan kuasi eksperimen dengan desain pretest–posttest control group yang melibatkan 68 siswa kelas X SMAN 1 Gondangwetan, Indonesia, yang dipilih melalui teknik cluster random sampling. Sampel terdiri atas kelas eksperimen ($n = 36$) dan kelas kontrol ($n = 32$). Data dikumpulkan menggunakan tes uraian yang telah memenuhi kriteria validitas dan reliabilitas untuk mengukur pemahaman konseptual siswa pada materi trigonometri. Hasil penelitian menunjukkan bahwa siswa yang belajar menggunakan model Discovery Learning berbantuan Powtoon memperoleh skor N-gain sebesar 0,43 (kategori sedang), lebih tinggi dibandingkan dengan kelas kontrol yang hanya memperoleh skor N-gain sebesar 0,06 (kategori rendah). Selain itu, hasil uji independent samples t -test menunjukkan adanya perbedaan yang signifikan antara kedua kelompok ($p = 0,001$). Sebagai kesimpulan, integrasi model Discovery Learning dengan media animasi Powtoon terbukti efektif dalam meningkatkan pemahaman konseptual dan hasil belajar siswa pada materi trigonometri. Temuan ini menunjukkan bahwa pemanfaatan media digital interaktif berpotensi menciptakan pembelajaran matematika yang lebih menarik, bermakna, dan berpusat pada siswa di jenjang pendidikan menengah.

Kata kunci: Discovery Learning, Powtoon, Trigonometri, Hasil Belajar, Pemahaman Konseptual.

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Introduction

Education is a long-term investment that shapes the future of a nation (Satiti, 2019), with mathematics being one of the key foundations for understanding science and technological progress (Siagian, 2016; Situmorang, 2016). Although proficiency in mathematics is vital for solving problems

in everyday life (Bernard & Chotimah, 2018; Maspupah & Purnama, 2020), pupils' academic achievement in complex topics such as trigonometry remains relatively low (Kamber & Takaci, 2018; Nurafni et al., 2020).

The main problem in teaching trigonometry lies in the high level of abstraction of the subject matter, which makes it difficult for pupils to visualise the relationships between the angles and sides of a triangle (Obeng et al., 2024). Consequently, pupils tend to memorise formulas without meaningfully understanding the concepts, which in turn leads to low motivation and a lack of critical and analytical thinking skills (Lu'lu'il Maknun et al., 2022). A number of studies have sought to address this challenge. The application of the Discovery Learning model has proven effective in encouraging students to actively explore concepts and think critically (Niman et al., 2024; Subagis, 2021; Wiono & Meriza, 2022). On the other hand, the integration of technology-based media such as Powtoon animations has been shown to enhance engagement and facilitate the visualisation of abstract material (Ekayani, 2017; Pais et al., 2017). Nevertheless, the majority of previous studies have still examined the Discovery Learning model and Powtoon animation separately or have merely looked at their impact on general cognitive learning outcomes (Mutmainnah & Kaharuddin, 2025). Studies that explicitly explore how the integration of Discovery Learning, oriented towards interactive visualisation via Powtoon, can guide students' logical thought processes through the verification phase to the drawing of conclusions regarding complex trigonometric concepts remain limited.

The novelty of this study lies in the synergistic integration of the constructivist stages of Discovery Learning with the dynamic Powtoon animation medium, specifically designed as visual scaffolding (Suliyadi et al., 2024). This combination not only creates an engaging learning environment but also conceptually transforms abstract trigonometry material into concrete representations that facilitate students' long-term memory retention and analytical thinking (Resmol & Leasa, 2022). Previous research has demonstrated the effectiveness of the Discovery Learning model in fostering independent thinking (Chintyandini et al., 2024) and the role of Powtoon in enhancing the visual appeal of mathematics content (Tini et al., 2023; Tiwow et al., 2022). However, the independent application of Discovery Learning often encounters obstacles in the initial stage (stimulation), where pupils struggle to understand abstract concepts without interactive visual aids. The integration of Powtoon into the Discovery Learning framework serves to bridge this gap, acting both as a medium for visualising abstract concepts and as a guide for the independent discovery process. Therefore, this study aims to analyse the extent to which Discovery Learning-based mathematics learning, systematically integrated with Powtoon, is effective at State Senior High School 1 Gondangwetan.

Previous studies have demonstrated that both Discovery Learning and technology-assisted learning media can improve students' mathematical understanding and learning outcomes. However, empirical evidence regarding the integration of Discovery Learning with Powtoon animation media, particularly in teaching trigonometry at the secondary school level, remains limited. Moreover, few studies have directly compared the effectiveness of this integrated approach with conventional instructional methods using a quasi-experimental design. Therefore, this study aims to investigate the effect of Powtoon-assisted Discovery Learning on students' trigonometry learning outcomes and to compare the learning outcomes of students taught using this approach with those receiving conventional instruction.

Method

This study was conducted over approximately one month during the second semester of the 2024/2025 academic year at State Senior High School 1 Gondangwetan, Pasuruan, with a population comprising all 386 Year 10 pupils. Sampling was carried out using a purposive sampling technique, based on considerations of the pupils' initial ability levels and the recommendations of the subject

teachers. The selected sample comprised 68 students divided into two groups: Class X-9 (32 students) as the control group and Class X-11 (36 students) as the experimental group. The research variables included the independent variable (X), namely the application of the Discovery Learning model supported by Powtoon, and the dependent variable (Y), namely the students' mathematics learning outcomes (Siswono, 2019).

This study employed a quantitative approach using a quasi-experimental design to analyse the effect of implementing the Discovery Learning model, supported by Powtoon animations, on pupils' learning outcomes (Creswell, 2017; Sugiyono, 2017). The research design used was a Non-equivalent Control Group Design, in which the experimental and control groups were not selected at random on an individual basis, as the study utilised pre-existing classes (Sukarelawa et al., 2024). The research procedure began with the preparation of instruments and the administration of a pre-test to both groups. Subsequently, the experimental group received the intervention in the form of Discovery Learning supported by Powtoon, whilst the control group used conventional teaching methods. The study concluded with the administration of a post-test, the completion of questionnaires, observation, and documentation for data collection.

Tabel 1. Research Design

Group	Pretest	Treatment	Posttest	Questionnaire
Experiment	O_1	X	O_2	A
Control	O_3	-	O_4	-

Description:

O_1 : Pretest for the control group

O_2 : Posttest for the control group

X : Treatment

O_3 : Pretest for the treatment group

O_4 : Posttest for the treatment group

A : Student response questionnaire

The data collection instruments used in this study included learning outcome tests (pre-test and post-test essay questions to measure initial understanding and mastery of the subject matter), observation sheets for teacher and pupil activities, pupil response questionnaires, and documentation (Martono, 2024). The teaching materials used comprised teaching modules, student worksheets (LKPD), and Powtoon animation media based on trigonometry (Sutriyanti & Muspawi Mohamad, 2024). Data collection was carried out by administering pre-tests and post-tests to both groups, observing the learning process, and distributing response questionnaires to the experimental class. Data analysis comprised descriptive and inferential statistics (Sofwatillah et al., 2024). Once the prerequisite tests namely the normality and homogeneity tests had been met (Sugiyono, 2017), the hypothesis regarding differences in learning outcomes between the experimental and control groups was analysed using an Independent Samples t-test with the aid of SPSS 29. In addition to statistical significance (p-value), this study also calculated the effect size using Cohen's d to measure the practical contribution of the application of Discovery Learning supported by Powtoon to the improvement in pupils' learning outcomes (Putra et al., 2023).

Result and Discussion

This study is a two-group experiment conducted at SMAN 1 Gondangwetan from February 26 to March 10, 2025. The research subjects there were two groups: the experimental group (X-11) and the control group (X-9). The teaching material used in this study was trigonometry. The experimental group received instruction using the discovery learning model supported by Powtoon animation media, while the control class utilized the conventional lecture method. To ensure initial equality, a pre-test

was administered to both groups before of acquiring knowledge began. Subsequently, A test was administered after the main evaluation to measure student learning outcomes, consisting of five essay questions with an allocation of 45 minutes.

A total of 68 learners took part in this research, in the experimental group, there are 36 students, while in the control group, there are 32 students. The primary data collection was carried out through three methods: observation (to monitor class conditions and the learning process), tests (to measure the level of material mastery), and questionnaires (to determine students' responses to the learning process). The results from the post-test were then analyzed to assess how well the Powtoon-supported discovery learning model enhances students' academic performance.

1. Powtoon Animation Video Results

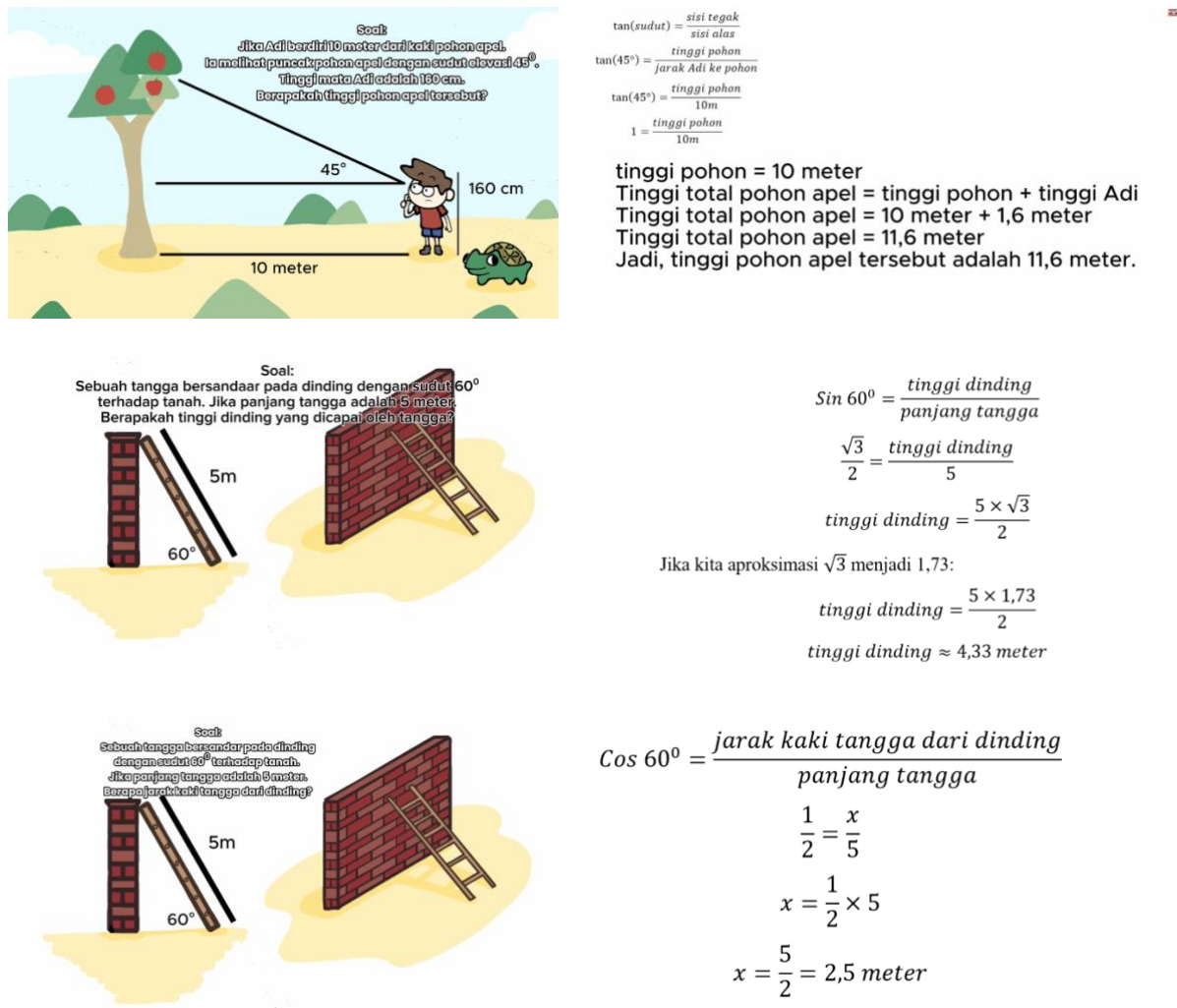


Figure 1. Powtoon Animated Video Preview

The use of Powtoon animation in the discovery learning model is demonstrated through a series of interactive trigonometry lessons as follows: Stimulation and Problem Statement Stage (Contextual Problems): The media presents mathematical problems with interactive visuals, such as an illustration of the character 'Adi' observing the top of an apple tree at an angle of elevation of 45° from a distance of 10 metres, with the observer standing at a height of 160 cm, as well as a problem involving a 5-metre-long ladder leaning against a wall at an angle of 60° . Data Processing and Proof Stage (Systematic Solution): The media displays a detailed proof flow for trigonometric ratio concepts, including: The use of the tangent concept ($\tan 45^\circ = \frac{\text{vertical side}}{\text{horizontal side}}$) to determine the total height of the apple tree as 11,6

metres. The use of the sine concept ($\sin 60^\circ = \frac{\text{vertical side}}{\text{sloping side}}$) to calculate the height of the wall reached by the ladder (approximately 4,33 metres). The use of the cosine concept ($\cos 60^\circ = \frac{\text{horizontal side}}{\text{sloping side}}$) to calculate the distance from the foot of the ladder to the wall (2,5 metres). Through this dynamic and step-by-step visualisation, the Powtoon platform has proven effective in helping pupils at State Senior High School 1 Gondangwetan to understand the application of trigonometric formulas to real-life situations in a more concrete way.

Table 1. Validity Test Results for Pre-test and Post-test Questions

No. Test	N	Sig.	Pearson Correlation	Interpretasi Validitas	Sig.	Pearson Correlation	Interpretasi Validitas
			Pretest			Posttest	
1	30	0,022	0,708	Good	0,013	0,745	Good
2	30	0,001	0,868	Good	0,005	0,807	Good
3	30	0,012	0,753	Good	0,011	0,759	Good
4	30	0,007	0,785	Good	0,045	0,641	Good enough
5	30	0,024	0,699	Good enough	0,021	0,713	Good

The test instrument was pilot-tested on a test group outside the research sample (N = 30 Year 11 pupils at Gondangwetan State Senior High School No. 1 who had studied trigonometry). Item validity was tested using Pearson's product-moment correlation formula as described by Sugiyono (2017), with the decision criterion being $r_{\text{calculated}} > r_{\text{table}}$ (0,361 at $\alpha = 0,05$). The test results in Table 2 show that all five pre-test and post-test items yielded calculated r values ranging from 0,641 to 0,868, with a significance level of $p < 0,05$. As all calculated r values were greater than 0,361, all items in the test instrument were deemed valid for measuring students' mastery of trigonometric concepts.

Table 2. Reliability Test Outcomes for Pretest and Posttest Questions

Jenis Soal	N of Items	Cronbach's Alpha	Interpretasi Reliabilitas
Pretest	5	0,818	Good
Posttest	5	0,781	Good

According to the table presented above, the Cronbach's Alpha value assigned to the pretest question is 0,818 and for the posttest question is 0,781. This value indicates that the five pre-test and posttest items have high reliability and are declared reliable.

Table 3. Results of Pretest and Posttest for Experimental and Control Groups

Value Interval	Experimental Groups		Control Groups	
	Pre-test	Post-test	Pre-test	Post-test
0 – 20	0	0	0	0
21 – 40	4	0	3	1
41 – 60	14	2	13	14
61 – 80	17	24	16	17
81 – 100	1	10	0	0
Minimum Value	34	56	34	36
Maximum Value	84	100	80	82
Average	58,72	77,56	58,25	60,75

Based on the table presented, there are differences in the extreme values and averages between the two groups. The Experimental Groups showed A pre-test score of no less than 34 and a post-test score of at least 56 are required. The highest score on the pre-test was 84, while the highest score on the post-test achieved 100. The experimental class achieved average scores of 58,72 on the pre-test and 77,56 on the post-test. The Control Class noted a lowest pre-test score of 34 and a lowest post-test score

of 36. The highest scores obtained were 80 on the pre-test and 82 on the post-test. Furthermore, the average scores for the control class were 58,25 for the pre-test and 60,75 for the post-test. The various outcomes can be further seen in the image provided.

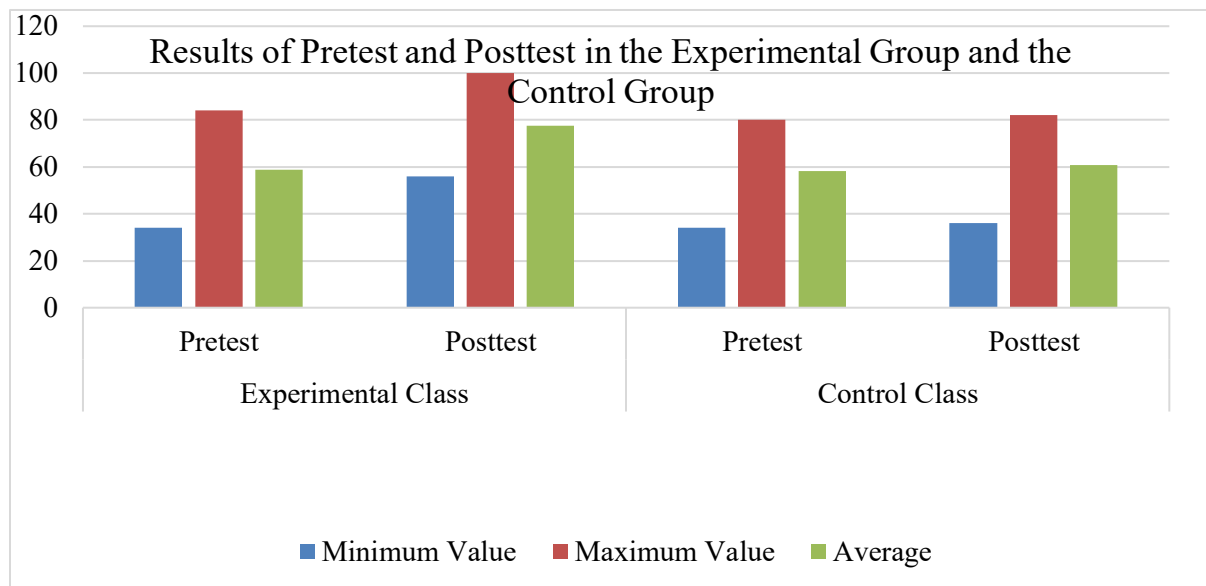


Figure 2. Differences in pretest and posttest results in the experimental and control classes

Table 4. Normality Test Results

Class	Kolmogorov-Smirnov			Shapiro-wilk		
	Statistic	df	Sig.	statistic	df	Sig.
Pretest A (Control)	0,123	32	0,200	0,965	32	0,367
Posttest A (Control)	0,094	32	0,200	0,982	32	0,857
Pretest B (Experimen)	0,110	36	0,200	0,967	36	0,358
Posttest B (Experimen)	0,121	36	0,200	0,954	36	0,139

Based on the table above, the Significance value (2- tailed) obtained by the Shapiro-Wilk test for the pretest in the control class is 0,367 while for the posttest in the control class is 0,857. Because $0,367 > 0,05$ and $0,857 > 0,05$. Then the population is considered normally distributed. Likewise, the experimental class pretest results were 0,358 while the experimental class posttest was 0,139. Where $0,358 > 0,05$ and $0,139 > 0,05$, the population is considered to have a normal distribution.

Table 5. Homogeneity test results

	Levene Statistic	Df 1	Df 2	Sig.
According to the Average	0,295	1	66	0,589
According to the Median	0,274	1	66	0,602
According to the Median and with Adjusted df	0,274	1	65,930	0,602
According to the Adjusted Average	0,295	1	66	0,589

The homogeneity test was conducted utilizing SPSS software version 29.0 for Windows, as indicated by the information presented in the accompanying table. The results of the analysis indicate that the significance value is 0,589. Since the significance value (0,589) exceeds the predetermined alpha limit (0,05), we accept the null hypothesis (H_0) and reject the alternative hypothesis (H_a). The understanding of this finding is that both sample groups originate from populations with similar variances or are considered homogeneous.

Table 6. Results of the n-gain score analysis

Class	Average					
	Posttest Score	Pretest Score	Posttest-Pretest	Ideal Skor	N-Gain Skor	N-Gain Skor (%)
Experimental	77,28	58,72	18,56	41,28	0,43	43%
Control	60,75	58,25	2,50	41,75	0,06	6%

Based on Table 7, students' initial ability in trigonometry was relatively balanced, as seen from the average pretest scores of the experimental class (58,72) and the control class (58,25). After receiving the treatment, the experimental class, which used the discovery learning model assisted by Powtoon, saw an increase in posttest scores to 77,28, with a difference of 18,56. Meanwhile, the control class only increased to 60,75, with a difference of 2,50. The analysis results show that the experimental class achieved an N-Gain Score of 0,43 (43%), while the control class only reached 0,06 (6%). This indicates that using the discovery learning model with Powtoon media has a significant positive impact on students' understanding of trigonometry concepts compared to conventional methods.

Table 7. Results from the independent sample t-test

	F	Sig	T	Df	Significance	
					One-Sided p	Two-Shided p
Equal variances assumed	0,295	0,589	-6,281	66	0,001	0,001
Equal variances not assumed			-6,261	64,117	0,001	0,001

Based on the information within the table over, the degree of freedom (df) is 66 and the significance value is 0,001. with a significance value of 0,001. Referring to the established hypothesis testing criteria, with a significance level of $\alpha = 0.05$ and the significance level of the test result is 0,001, the significance level is smaller than the significance level ($0,001 < 0,05$). As a result, we dismiss the null hypothesis (H_0) and embrace the alternative hypothesis (H_a). This indicates a variation in the typical academic results of learners among the group that implemented the Discovery Learning method supported by Powtoon animation media as the experimental class and the class that did not implement the model or used conventional methods as the control class. Thus, the implementation of the Discovery Learning method aided by Powtoon animation media in teaching and learning activities can influence student learning outcomes.

Based on the data analysis, this study shows that implementing the discovery learning model assisted by Powtoon animation media has a significant impact on students' understanding of concepts and their trigonometry learning outcomes. This is evidenced by the N-Gain score of 0.43 (medium category) in the experimental class, which is much higher than the control class with an N-Gain of 0.06 (low category). This considerable difference in improvement is further confirmed through the Independent Sample t-Test, which produced a significance value of $p = 0.001$ ($p < 0.05$). These results clearly reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a), indicating a significant difference in learning outcomes between the class applying discovery learning with Powtoon and the class using conventional learning.

The significant success in the experimental class can be attributed to the harmonious synthesis between the discovery learning model and the integration of Powtoon visual media. Trigonometry has often been perceived by students as an abstract math topic, with complicated formulas, and considered difficult to understand through standard expository methods. The implementation of the discovery learning model facilitates a shift in the learning paradigm from teacher-centered to student-centered. Through the stages of discovery-such as providing stimulation, identifying problems, collecting data, and verification-students are required to actively build their understanding of trigonometry concepts themselves, rather than merely memorizing formulas.

The role of Powtoon animation media acts as an accelerator in the stages of stimulation and information processing. Powtoon presents trigonometry material in a dynamic, engaging, and interactive audio-visual format. This helps make abstract trigonometry concepts (like sine and cosine ratios or trigonometric function graphs) concrete into visual forms that are easy to understand. This audio-visual integration aligns with Cognitive Load Theory and Sweller's Multimedia Learning, where presenting material through two processing channels (visual and auditory) simultaneously can reduce excessive cognitive load and improve long-term retention.

The findings of this study reinforce and are relevant to several previous studies. Research by Suliyadi et al., (2024) confirmed that the discovery learning model consistently stimulates critical thinking and mathematical problem-solving skills in students. Additionally, these findings are also in line with the research conducted by Tiwow et al., (2022), which found that the use of technology-based animated media like Powtoon significantly boosts student motivation, active engagement, and academic achievement in mathematics lessons.

Even though the initial scores (pretest) of both classes were relatively balanced (experiment: 58.72; control: 58.25), the drastic improvement in the experiment class shows that combining discovery learning and Powtoon not only makes the class more interactive but also fundamentally improves students' understanding of math. On the other hand, in the control class using conventional methods, students tended to be passive and relied on procedural exercises, making them less capable of fully grasping trigonometry concepts when faced with posttest questions.

In practical terms, the results of this study provide recommendations for math educators to integrate audiovisual-based media into inquiry/discovery-based learning strategies. Modern math teaching requires a contextual and technological approach to spark critical thinking and keep students' attention in the digital age. Although the results are positive, this study has some limitations because the intervention was only applied to one basic trigonometry subtopic, and the sample came from just one school (SMA Negeri 1 Gondangwetan). For future research, it would be great to test how effective this approach is on more complex math topics (like calculus or 3D geometry) and to observe the long-term effects, like memory retention a few months after the intervention.

Conclusion

Based on the data analysis and discussion, it can be concluded that implementing the discovery learning model with the help of Powtoon animation media has a significant positive effect on students' learning outcomes and understanding of trigonometry concepts. This is shown by the much higher N-Gain Score in the experimental class compared to the control class that used conventional methods. In addition, the independent sample t-test results confirmed a significant difference in learning outcomes between the two groups. Integrating Powtoon media into the discovery learning syntax has proven effective in turning abstract trigonometry material into more visual and interactive content, which can boost students' active engagement and retention of math understanding.

The implication of this research shows that using interactive audiovisual media like Powtoon can be an effective alternative learning strategy for abstract math topics. For educators, it's recommended to combine discovery-based learning models with interactive technology media to create a more conducive, student-centered learning environment. For future research, it's suggested to test the effectiveness of this combination on a wider range of math topics and to measure other student psychological variables like learning motivation, learning independence, or mathematical critical thinking skills.

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