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The Influence of the Discovery Learning Model Assisted by Articulate Storyline on Students' Mathematical Resilience

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Abstract- This research seeks to examine how the Discovery Learning approach, when supported by Articulate Storyline, impacts students' resilience in mathematics. In an educational landscape rapidly evolving due to technological progress, a key priority for educators is to leverage ICT advancements to elevate teaching and learning standards. This research was conducted at SMAN 2 Rambatan on grade XI students, focusing on mathematics subjects, especially inverse functions and function composition. A quasi-experimental model was applied, structured around a nonequivalent control group design that collected data solely through posttests. Respondents comprised 51 students, divided into experimental (26) and control (25) groups. Data were collected using a 30-item instrument designed to evaluate resilience in mathematics. The analysis revealed that the Discovery Learning model, when supported by Articulate Storyline, significantly enhanced students' mathematical resilience compared to traditional teaching methods ($p = 0.031$). This finding confirms the importance of developing mathematical resilience through interactive and technology-based learning approaches, which can help students face challenges in the mathematics learning process. This study advances the development of innovative instructional strategies to enhance student academic performance within the framework of 21st-century education.

1. Introduction

The integration of ICT into education highlights their mutual dependence, with technological growth fueling pedagogical innovation. The rapid advancement of

Science and technology do not always lead to positive outcomes; it also has negative impacts (Rasa & Laherto, 2022; Yu, 2024). This presents a challenge for teachers and educators to enhance quality by maximising the use of technological and informational advancements, as teachers are key components of educational activities and the learning process (Aldowah et al., 2017; Okoye et al., 2023). Therefore, education is essential in addressing various challenges that may arise. Education plays a crucial role in improving and developing the quality of human resources (Garg et al., 2022; Sulisworo, 2016). The development of science and technology in various aspects of life, including education, necessitates that both teachers and students develop 21st-century skills, commonly referred to as the 4Cs. This competence is known as the 4C competency. Such capabilities include problem-solving through critical thought, creativity, proficient communication, and successful collaboration in group settings (Ojo, 2019; Supena et al., 2021).

In the process of learning mathematics, students will encounter difficulties and obstacles in solving mathematical problems, which may decrease their motivation to learn (Akhter & Akhter, 2018; Wawan & Retnawati, 2022). Aligned with this standpoint, Hutauruk & Priatna (2017) state that challenges and obstacles encountered in learning mathematics can create significant stress and lead to unfavourable conditions. Therefore, it is necessary to develop resilience, which plays a crucial role in overcoming these challenges (Hafiz et al., 2017; Johnston-Wilder et al., 2014). Thus, there is a relationship between resilience abilities and students' mathematics learning outcomes. Students with high resilience will achieve better learning outcomes due to their diligent, persistent attitude and self-confidence (Mahayani et al., 2023). This is confirmed by previous research, which found that higher resilience is associated with higher students' mathematics learning outcomes (Nabilah et al., 2024; Xenofontos & Mouroutsou, 2023). Based on observations made at SMAN 2 Rambatan with grade XI students, several problems were identified that negatively affected students' learning outcomes and attitudes towards mathematics. The mathematics performance outcomes of grade XI students, as presented in Table 1, reveal that a substantial proportion have not yet reached the anticipated competency level.

Table 1. Average Score of Students' Summative Assessment Grade XI, SMAN 2 Rambatan, Academic Year 2024/2025

No.	Class	Highest Score	Lowest Score	Average Score	Number of Students	Passing Students
1	XI F1	90	28	64,44	26	8
2	XI F2	95	31	63,6	25	9
3	XI F3	95	30	63,76	26	8
Total					77	25

Source: Administration Office of SMAN 2 Rambatan

Students with low mathematical resilience tend not to fully and logically utilise their reasoning when solving problem-solving test questions. They rely on calculation methods based on what they already believe to be correct, even though they often forget formulas or fail to understand the core of the question (Attami et al., 2020; Ozturk & Guven, 2016). They also appear more prone to giving up easily and lack perseverance in solving problem-solving questions. Students categorised as having low mathematical resilience exhibit low perseverance, i.e., tend to give up easily when facing difficulties (Johnston-Wilder et al., 2014; Rohmah et al., 2020). From this analysis, it is evident that students with low mathematical resilience are more likely to surrender when encountering challenges in problem-solving tasks.

When a person has good resilience, they are less likely to be stressed when facing difficulties because they consistently seek the best alternatives to solve their problems (Siregar et al., 2023). High mathematical resilience correlates with the skill to participate productively in group work involving mathematical concepts and problem-solving (Hafiz et al., 2017; Neumann et al., 2021). Resilience is the skill of confronting inevitable hardships with positivity, leveraging them as catalysts for self-improvement. In an educational context, it reflects students' affective strength in tackling learning-related difficulties, surmounting them and emerging more capable (Hutauruk & Priatna, 2017; Shengyao et al., 2024). Mathematical resilience refers to a learner's capacity to confront and manage challenges encountered in mathematical learning, enabling them to persevere, adapt strategies, and sustain effort

despite setbacks (Amelia et al., 2020; Cousins et al., 2019). Developing this resilience is essential, as mathematics often requires critical thinking, problem-solving skills, and perseverance.

Based on the statements above, it is essential to enhance students' mathematical resilience. One learning model expected to enhance students' mathematical resilience is the discovery learning model. The Discovery Learning method is an instructional approach that structures learning experiences so students independently uncover knowledge they have not previously encountered, either partially or entirely, without direct instruction from the teacher (Kurniawati et al., 2021; Putriani & Rahayu, 2018). By integrating Discovery Learning, students actively build knowledge by exploring concepts firsthand rather than passively receiving information (Afriyanti et al., 2018; Setiawan & Daud, 2024). Hafiz (2017) states that through Discovery Learning, students can strengthen their mathematical resilience by actively constructing knowledge and overcoming obstacles. The discovery learning model encourages students to explore and investigate mathematical concepts actively. The discovery learning model is widely regarded as highly effective in educational practice, as it fosters critical thinking and motivates students to actively generate solutions to problems (Kamaluddin & Widjajanti, 2019; Ristanto et al., 2022). Additionally, it strengthens students' ability to tackle challenges confidently and enhances their capacity to internalise and master learned concepts. In line with this statement, Afriyanti et al. (2018) state that the discovery learning model enhances students' resilience by encouraging them to independently explore, analyse, and construct conceptual understanding, thereby making them more adaptive to challenges and setbacks in the learning process.

The research employs Discovery Learning enhanced with Articulate Storyline, embedding mathematical resilience within the instructional steps. The learning model supported by Articulate Storyline enables students to learn in groups interactively through engaging digital media. As an application, Articulate Storyline enables the design of technology-integrated learning tools, such as dynamic digital courses and simulations (Daryanes et al., 2023; Ritonga et al., 2022). Additionally, Articulate Storyline functions as a presentation medium (Pratama, 2018). Articulate Storyline is a dynamic multimedia tool tailored for teachers and students, enabling interactive, engaging educational experiences. Its intuitive, PowerPoint-like interface simplifies content creation, while customizable publishing options allow users to tailor outputs to their needs. The tool is web-accessible, leveraging HTML5 compatibility for seamless use across computers and mobile devices (Hadza et al., 2020; Sindu et al., 2020). Based on the aforementioned explanation, the researcher selected the Discovery Learning Model, assisted by Articulate Storyline, to examine its effect on students' mathematical resilience. Given these considerations, the researcher initiated an investigation titled "The Influence of the Discovery Learning Model Assisted by Articulate Storyline on Students' Mathematical Resilience".

2. Methods

(a) Settings

This research was conducted on grade XI students of SMAN 2 Rambatan, Tanah Datar Regency, West Sumatra Province, Indonesia, in the 2024/2025 academic year. The subject examined in this study is mathematics, focusing on inverse functions and function composition. Throughout the study, the researcher served as an observer in both treatment groups. Approval from the school principal was secured before initiating the research.

(b) Participants

The research participants included 51 SMAN 2 Rambatan students studying mathematics in the first semester of the 2024/2025 school year. The experimental and control groups consisted of 26 and 25 students, respectively. It was noted that all students participated voluntarily in this study. Descriptive statistics regarding the participants are shown in Table 2.

Table 2. Descriptive statistics about participants

	Gender		Total	Age Range (years)
	Male	Female		
Experimental	11	15	26	16-18
Control	10	15	25	16-18
Total	21	30	51	16-18

(c) Design

This study utilises a quasi-experimental design to investigate how the Discovery Learning Model, enhanced by Articulate Storyline, affects students' mathematical resilience in mathematics subjects. The research design used was the Nonequivalent Posttest Only Control Group Design. The research design is presented in Table 3.

Table 3. The Nonequivalent Posttest Only Control Group Design

Group	Treatment	Post-test
Experimental	X_1	O
Control	X_2	O

Notes:

X_1 : treatment with the Discovery Learning Model assisted by Articulate Storyline;

X_2 : treatment with a conventional learning model;

O : giving the mathematical resilience questionnaire test.

(d) Instruments

This research utilised a non-assessment instrument to gather data. The non-test instrument consists of a mathematical resilience questionnaire designed to assess students' levels of mathematical resilience. The questionnaire consists of 30 items with both positive and negative statements, adapted from (Amelia et al., 2020) indicators, which include: (1) demonstrating perseverance, confidence, hard work, and determination in facing problems, failures, and uncertainties; (2) exhibiting a willingness to socialize, readily offering help, engaging in discussions with peers, and adapting to their environment; (3) generating new ideas/approaches and seeking creative solutions to challenges; (4) using past failures as motivation for self-improvement; (5) having curiosity, reflecting, conducting inquiries, and utilizing various resources; and (6) possessing language skills, self-control, and awareness of their emotions. To evaluate mathematical resilience, the study utilised a Likert scale comprising four response categories: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).

(e) Data Analysis

Using the Nonequivalent Posttest-Only Control Group framework, this study analyses data to assess the effect of the Articulate Storyline-enhanced Discovery Learning Model on learners' mathematical resilience. Data analysis is conducted by comparing the posttest results of the mathematical resilience assessment between the experimental group, which received Discovery Learning assisted by Articulate Storyline, and the control group, which received conventional learning. Before parametric analysis, the dataset will undergo tests of normality and homogeneity. Provided the assumptions of normality and homogeneity are met, the study will employ an Independent Samples t-Test to determine whether there are meaningful differences between the groups. The Mann-Whitney U Test will substitute for parametric tests if the data fail normality/homogeneity criteria, with SPSS facilitating the analysis.

3. Results and Discussion

The results of the statistical analyses, comprising normality and homogeneity tests followed by a t-test, are discussed in this section to assess the influence of the Discovery Learning Model, enhanced by Articulate Storyline, on students' mathematical resilience in mathematics instruction. The Shapiro-Wilk

test was used to assess the normality of the data, and the results indicated adherence to normality (Table 4). Homogeneity of variance was subsequently verified using the Levene test, as shown in Table 5.

Table 4. Normality Test Results

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Mathematical Resilience	Experimental	,166	26	,062	,926	26	,063
	Control	,152	25	,139	,920	25	,052

Table 5. Homogeneity Test Results

Mathematical Resilience		
df1	df2	Sig.
1	49	,843
df1	df2	Sig.

The Shapiro-Wilk test confirmed a normal distribution of the data in Table 4, and the Levene test validated homogeneity of variance across the population in Table 5. Therefore, the data were analysed using the t-test. Table 6 presents the t-test results comparing self-efficacy between the experimental group, which used the Discovery Learning Model enhanced with Articulate Storyline, and the control group, which employed a traditional/conventional instructional approach.

Table 6. Normality Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mathematical Resilience	Equal variances assumed	,039	,843	2,220	49	,031	9,6064	4,3273	,9104	18,3025
	Equal variances not assumed.			2,218	48,609	,031	9,6064	4,3316	,9000	18,3129

The Independent Samples Test revealed a statistically significant difference between groups, as evidenced by a two-tailed significance value of 0.031 ($p < 0.05$) under the assumption of equal variances. According to the independent-samples t-test criteria, the data provide sufficient evidence to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a). The analysis reveals that the Experimental Class exhibits, on average, significantly higher mathematical resilience than the Control Class, as supported by statistical evidence. The statistical analysis reveals a significant impact on students' mathematical resilience between these two groups.

The research findings indicate that students' mathematical resilience, when taught through the cooperative learning model of the Discovery Learning Model enhanced by Articulate Storyline, was significantly higher than that of students instructed using conventional learning models. Students in the experimental group, who received instruction via the Discovery Learning Model, supported by Articulate Storyline, recorded an average mathematical resilience score of 76.34. In contrast, the control class obtained an average score of 66.375. These findings suggest that the Discovery Learning Model, supported by Articulate Storyline, positively impacts students' mathematical resilience, with the effect categorised as moderate.

The implementation of the Discovery Learning model, enhanced with Articulate Storyline, has the potential to strengthen students' mathematical resilience through structured, exploration-oriented learning phases. This approach allows students to be more actively engaged in understanding mathematical concepts and in developing perseverance and confidence in solving problems.

In the stimulation stage, the teacher uses Articulate Storyline to present the material with interesting visual displays, interactive simulations, and illustrations relevant to everyday life. The goal is to stimulate students' curiosity and build early engagement in learning. Through engaging animations and scenarios, students are encouraged to explore math concepts more actively. This interactive presentation

of the material also helps reduce students' anxiety about math, so they feel more confident moving on to the next stage. Figure 1 shows the login or cover page and the activities during the stimulation stage on the Articulate Storyline interface.

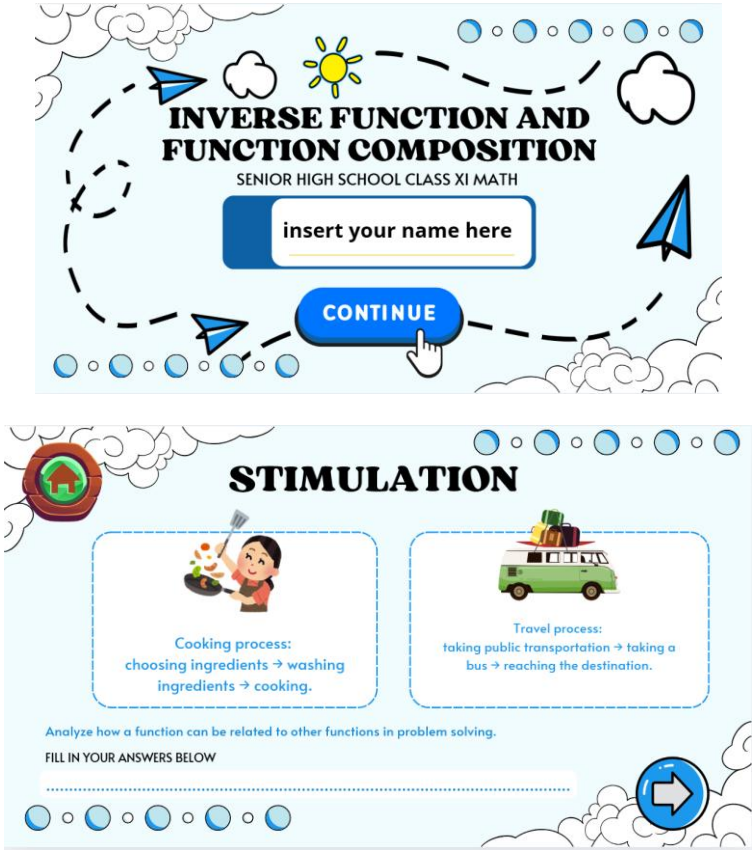
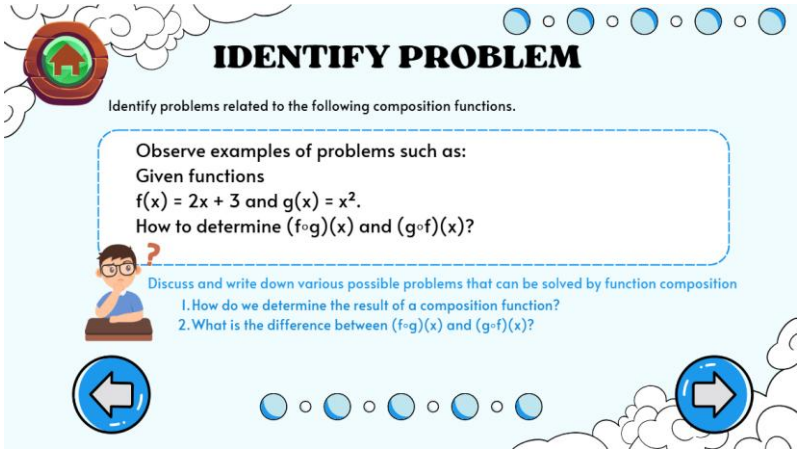


Figure 1. Cover and Stimulation Stage

The identify problem stage encourages students to recognise and understand the mathematical problems in the scenario or simulation presented. Through Articulate Storyline, students can observe patterns, conduct simple experiments, and answer triggering questions that help them understand the problem at hand. In this stage, students learn not to be afraid of difficulties and instead have more courage to explore possible solutions. This attitude is an important basis for building mathematical resilience, because students are accustomed to facing challenges by first identifying the core of the problem before giving up. The display of activities that identify the problem stage and verify the data stage in Articulate Storyline is shown in Figure 2.



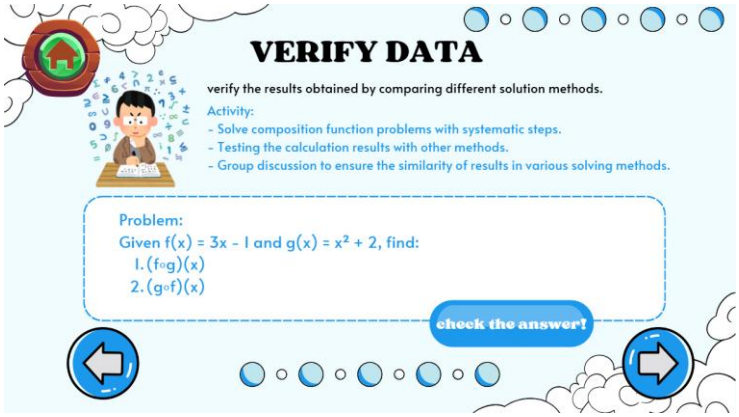


Figure 2. The identify problem stage and the verify data stage

During the data collection phase, students begin gathering the information necessary to address the identified problem. Articulate Storyline plays a role in providing various data sources in the form of graphs, tables, or interactive simulations that allow students to experiment and see the relationship between concepts more clearly. With this approach, students are trained to process information independently and develop an analytical mindset in solving math problems. This exploration process also builds mental resilience, as students learn to seek alternative ways to understand concepts rather than becoming frustrated when they encounter difficulties.

After collecting data, students enter the verify data stage to ensure the correctness of their solutions. At this stage, they can discuss their findings with their groupmates or use the quiz and exercise features in Articulate Storyline to evaluate their understanding. This verification activity helps students develop a critical and meticulous attitude toward checking their work and familiarise them with the systematic correction of errors. In addition, this process also strengthens mathematical resilience, as students learn that mistakes are not failures, but rather part of the learning process that must be corrected with further effort.

In the last stage, summarise concept, students are asked to reorganise the concepts and principles they have learned during the learning process. With Articulate Storyline, students can work on reflective exercises, interactive quizzes, or construct concept maps to help them understand the material more thoroughly. This approach not only deepens students' understanding of mathematical concepts but also cultivates reflective thinking, which is a vital aspect of mathematical resilience. Students who regularly evaluate their learning processes will be better equipped to confront future academic challenges and less likely to give up when faced with new difficulties. Evaluation stages can be observed through Figure 3.

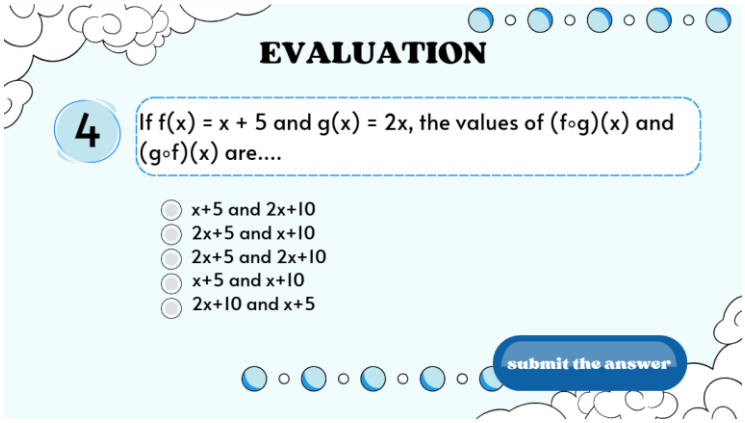


Figure 3. The evaluation stage

The implementation of Discovery Learning, supported by Articulate Storyline, enables students to not only enhance their understanding of mathematical concepts but also to cultivate perseverance, confidence, and motivation when confronting academic challenges. This approach creates a more interactive and supportive learning environment, so that students are better equipped to overcome difficulties in learning mathematics with a more positive and unyielding attitude.

The results align with the research conducted by Hafiz et al. (2017) regarding the discovery learning model, which asserts that discovery learning not only improves students' mathematical resilience but also fosters a deeper understanding of mathematical concepts. Furthermore, Prasetyo et al. (2022) assert that the design of discovery learning, supported by interactive learning media, can foster strong resilience in students.

The discussion reveals that the discovery learning model plays a crucial role in enhancing students' mathematical resilience by encouraging active exploration and critical thinking, thereby fostering a deeper understanding of mathematical concepts. When students engage in hands-on activities and inquiry-based tasks, they develop the confidence and persistence needed to tackle complex problems, thereby improving their resilience in mathematics. Moreover, integrating Articulate Storyline as an interactive learning medium significantly contributes to this process by offering dynamic multimedia features, such as simulations, interactive narratives, and visual aids, that make abstract concepts more accessible and engaging. This digital experience not only reinforces conceptual comprehension but also supports continuous learning by providing immediate feedback and varied learning pathways.

4. Conclusion

This study shows that the application of the Discovery Learning model, supported by Articulate Storyline, positively influences students' mathematical resilience. In an educational context increasingly influenced by advances in information and communication technology, it is important for educators to use tools and methods to improve the quality of learning. The results indicated that students who were instructed using the Discovery Learning model exhibited greater mathematical resilience than those who received instruction through the conventional learning model. Therefore, this study underscores the significance of fostering students' mathematical resilience as a crucial component of the learning process, while also demonstrating that integrating technology in education, such as Articulate Storyline, can enhance learning effectiveness and equip students to confront future challenges.

This study has several limitations: the discovery learning model, assisted by Articulate Storyline, was applied only in the context of mathematics instruction for grade XI high school students, so the findings cannot be generalised to other subjects or educational levels. Additionally, the limited time available for implementing instruction and evaluating students' mathematical resilience development indicates the need for a longer observation period to more thoroughly assess the impact of this learning model on academic performance. The study is also constrained by a relatively small sample size and limited research locations, which means that the diversity of student characteristics is not fully reflected in the results. Furthermore, other supporting variables, such as the optimal use of multimedia features in Articulate Storyline and learning environment conditions that may affect learning outcomes, could not be fully controlled.

The conceptual challenge for future researchers is to design innovative learning approaches that fully leverage digital technology to create interactive, contextualised learning experiences. Future research is recommended to explore variations in the application of the discovery learning model by utilising the multimedia features and interactive narratives provided by Articulate Storyline to enhance student engagement and mathematical resilience. So, future research should build on this work by using the same independent variable with different dependent variables, different independent variables with the same dependent variable, or the same independent and dependent variables but with different subject matter and research sites, so that the results obtained can complement each other. By integrating these elements, the research outcomes are expected to contribute significantly to the development of adaptive mathematics learning strategies in the digital era, thereby improving overall student achievement and mathematical resilience.

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