Digital Learning Innovations: Creative Thinking as a Mediator and Leadership Ability as a Moderator in the General Ability—Academic Attitude Relationship

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***Abstract*—In digital learning environments, cognitive and socio-emotional competencies play critical roles in shaping academic attitudes. This study investigates the effect of General Ability (GA) on Academic Attitude (AA) among elementary school students, with Creative Thinking (CT) positioned as a mediator and Leadership Ability (LA) as a moderator within the context of digital technology-based learning. A quantitative approach was employed involving 710 students in Padang, Indonesia. Data were collected via validated scales through hybrid administration and analyzed using descriptive statistics, network analysis, and Partial Least Squares-Structural Equation Modeling (PLS-SEM). The findings revealed that GA did not have a significant direct effect on AA, but became significant when mediated by CT, suggesting that creativity plays a pivotal role in converting cognitive ability into positive academic attitudes. Leadership ability moderated the relationship between GA and AA, but not between CT and AA. These results may reflect the nature of digital learning environments, which often require students to self-direct their learning and engage creatively with content, while leadership functions tend to emerge in collaborative contexts that are less central to individual attitude formation. The findings highlight the need for digital curricula that integrate opportunities for creative exploration and structured leadership experiences, particularly for high-ability students. Further research could examine how classroom dynamics, teacher support, or technological infrastructure shape these psychological and behavioral relationships.**

***Keywords*—digital technology-based learning, general ability, creative thinking, leadership ability, academic attitude**

I. Introduction

A Digital technology-based learning basically requires students to have an optimal academic attitude, which reflects enthusiasm for learning, perseverance, and high curiosity [1–3]. This attitude will encourage students to proactively seek additional information, utilize technological devices appropriately, and adapt to various innovations in the learning process. In today's digital era, students ideally have strong intrinsic motivation and are willing to utilize technology to deepen concept understanding, explore various online learning resources, and collaborate with classmates through digital platforms [4–7]. Furthermore, a positive academic attitude lays the foundation for learning independence and readiness to face the challenges of the 21st century, where higher-order thinking skills are essential [8–10]. For instance, digital platforms such as Google Classroom, Quizziz, and Kahoot! are widely used to deliver assignments, quizzes, and interactive discussions. While these tools have the potential to increase student motivation and engagement, their impact on academic attitudes may vary depending on how well they are integrated into instructional design.

However, the reality on the ground is not always as ideal as expected. Based on several recent studies, it is found that many elementary school students in Indonesia exhibit suboptimal academic attitude in the context of digital technology-based learning [11–13]. For example, some students tend to be more passive during online learning activities, reluctant to explore using learning applications, or even have difficulty managing time and focus when using devices for learning. This lack of active engagement can be caused by various factors, including a lack of environmental support, a lack of internal motivation, or a limited understanding of how to utilize technology as an effective learning tool [14–18]. If this issue is left unaddressed, there is a concern that a widening competency gap will emerge between students who are able to adapt to digital learning and those who are not [19–21].

This is where it is important to examine the key factors that have the potential to influence students' academic attitude. There are three variables that are thought to play a major role, namely: general ability, creative thinking, and leadership ability. General ability refers to general cognitive capacity that includes reasoning, problem solving, and speed of understanding information [22–25]. Creative thinking includes the ability to generate new ideas, see problems from various points of view, and combine concepts flexibly and originally [26–33]. Meanwhile, leadership ability at the elementary school level can be seen from students' ability to influence peers, communicate effectively in group discussions, and take initiative in joint tasks [34–38]. The combination of these three aspects is believed to help shape more positive academic attitudes in students. In this study, general ability is defined as students' capacity for reasoning, problem-solving, and information processing, which helps them navigate digital learning tasks efficiently. Operationally, this construct was measured using a four-item scale that assessed students' logical reasoning, pattern recognition,

adaptability to new information, and ability to draw accurate conclusions from data—skills aligned with the demands of digital learning environments. Creative thinking involves generating original ideas and applying flexible strategies—skills that emerge when students engage with digital tools to explore content or solve problems in unique ways. Within technology-based learning environments, general ability functions as the foundational cognitive resource that enables students to comprehend and process instructional content. However, it is through creative thinking that these cognitive resources are transformed into adaptive strategies and meaningful engagement, allowing learners to personalize their approaches, explore novel ideas, and sustain motivation throughout digital tasks.

In this study, general ability is positioned as an independent variable that is directly associated with academic attitude. Experts argue that students with higher general ability are generally faster at learning new information, adjusting to changes in learning formats, and absorbing digital learning concepts effectively [8, 39, 40]. However, academic attitude is not just a matter of basic ability; many students with good general ability are not motivated to explore their potential if their academic attitude is not well formed [41]. Therefore, it is important to consider how other factors can strengthen or weaken the influence of general ability on academic attitude, especially when digital technology-based learning requires students to be more independent and innovative.

On the other hand, creative thinking is thought to act as a mediator between general ability and academic attitude [33, 42–45]. This means that students with good general abilities will find it easier to develop creative thinking skills, thus influencing how they respond to the learning process. For example, students with high cognitive capacity will be more adept at experimenting with various digital learning resources, finding unique learning methods and solving problems that may arise during online learning. When this creativity grows, positive academic attitudes will be formed, because they feel interesting challenges and do not get bored quickly [46–49]. In digital learning, creativity enables students to stay motivated by allowing them to personalize tasks, explore multiple solutions, and engage more actively with technology. Without creative engagement, students may experience boredom, low interaction, or reliance on passive consumption of content. Thus, creative thinking can be a bridge (mediator) that strengthens the effect of general ability on academic attitude.

In addition to mediation by creativity, this study also considers leadership ability as a moderator variable in the general ability-academic attitude and creative thinking-academic attitude relationships [50–52]. When students have leadership ability, they are not only skilled at conveying ideas, but also able to motivate themselves and their peers to follow learning with discipline [53, 54]. In the context of digital learning, leadership ability may be realized when students take the initiative to help friends who have difficulty accessing the platform, moderate online group discussions, or design collaborative activities using technology. With the presence of this leadership ability, the influence of general ability and creative thinking on students' academic attitudes may become stronger, as the leadership role facilitates the adaptation process as well as active participation in technology-based learning activities.

Previous studies have focused more on the role of general ability and academic attitude directly, without looking at the mediation and moderation dynamics involving creativity and leadership. In fact, in the context of the 21st century, creative thinking and leadership are two important elements that are also demanded in various modern curricula. This is where the urgency lies to examine more deeply how creative thinking and leadership ability can support the formation of a strong academic attitude, especially in Indonesia, which is aggressively implementing digital technology-based learning at the elementary school level. This urgency is particularly relevant in Indonesia, where digital learning adoption remains uneven due to disparities in infrastructure, teacher digital literacy, and students' access to devices and stable internet connections—especially in rural or under-resourced areas. These gaps can hinder students' ability to engage creatively and take initiative in digital environments. By revealing a more comprehensive causal relationship, educators are expected to be able to design interventions that sharpen students' creativity and encourage leadership, so that academic attitudes can be formed more holistically. These interventions may include curriculum-based digital projects that promote creative expression, as well as technology-supported group tasks that assign rotating leadership roles to strengthen both academic engagement and peer collaboration.

Previous studies have typically examined the relationship between general ability and academic outcomes [24], or between creativity and leadership separately [31, 36]. However, very few have integrated general ability, creative thinking, and leadership ability simultaneously within the digital learning context. This study addresses this gap by offering a comprehensive model that captures their interactions. In terms of novelty, this study tries to combine the concepts of creative thinking as a mediator and leadership ability as a moderator in one complete theoretical framework. Previous studies may discuss one or two of these variables separately, but rarely integrate them together with general ability to assess their impact on academic attitude of elementary school students. While several studies have examined the effects of general ability, creativity, or leadership independently, few have explored their interaction within a single integrative model, particularly in the context of elementary students and digital learning [24, 31, 36]. This study offers a novel contribution by simultaneously positioning creative thinking as a mediator and leadership ability as a moderator—an approach that, to the best of our knowledge, has not been addressed in prior Indonesian research focused on primary education and technology-based learning. To the best of my understanding, this kind of integrative effort has not been done in Indonesia, especially in the context of digital learning. Research with this design can provide a deeper understanding of the key factors that influence academic attitude in the digital era, as well as an empirical basis for developing more innovative learning methods.

In addition, the originality of this research lies in emphasizing the role of leadership ability among elementary school students. So far, leadership is more often discussed at

the secondary or higher education level, while at the primary level, the concept of leadership is often seen as irrelevant. However, the facts on the ground show that children can already show leadership talent, for example in group work or when managing classroom dynamics when teachers ask them to do collaborative technology-based projects. By proving how leadership ability can moderate the influence of general ability and creative thinking on academic attitude, this research will strengthen the argument that leadership development should start early, not wait for students to be in higher education.

Therefore, this study seeks to make a significant contribution to the field of digital technology-based education, by showing an integrated relationship map between general ability, creative thinking, leadership ability, and academic attitude. In this study, leadership ability refers to students' capacity to coordinate, initiate, and guide peers in collaborative, technology-based learning activities. This includes managing group tasks on digital platforms, facilitating peer discussions, and ensuring shared responsibilities are completed effectively—skills increasingly relevant in project-based and remote learning environments. Understanding these mediating and moderating mechanisms will help teachers, educational practitioners, and policy makers in designing more efficient teaching strategies.

II. Literature Review

A. Digital Technology-Based Learning

The rapid development of digital technology has led to various innovations in the education sector, including technology-based learning methods and models. Digital technology-based learning includes the utilization of online platforms, educational applications, and the use of hardware such as computers, tablets and smartphones to enrich the teaching-learning process [55]. In the context of primary education, this approach provides opportunities for students to be more engaged interactively, independently, and collaboratively, so that the potential for improving concept understanding is greater [56, 57]. On the other hand, the use of technology in the classroom also requires adjustments to the curriculum and appropriate teaching approaches, so that teachers can facilitate the achievement of optimal learning objectives [58].

Despite the benefits, digital technology-based learning is not free from challenges. One of them is the digital divide, which is the gap in digital access and skills among students and teachers [59]. Researchers highlight the need for adequate infrastructure support, ongoing training for educators, and integration of relevant digital content with the curriculum [60]. In addition, students' adaptation to new features requires intrinsic motivation and a positive academic attitude to avoid excessive distraction or unproductive use of technology. If not handled properly, new problems will arise such as low student participation, boredom, and difficulty in realizing competency-based learning goals.

One approach often proposed to maximize the potential of digital learning is blended learning, where face-to-face learning is combined with online activities [61]. With this, students do not just receive one-way information, but also engage in discussions, interactive assignments and collaborative projects digitally. Technology-based learning also opens up the possibility to implement personalized learning, which adapts materials and learning pace to the individual needs of students. All these innovations ultimately aim to improve the quality of learning and encourage a better academic attitude among students.

The successful implementation of digital technology-based learning depends on various factors, including the support of the social environment, school capacity, and the characteristics of the students themselves [44]. According to several studies, student characteristics such as general ability and creative thinking greatly affect their adaptability to technology, while leadership ability factors help students lead themselves and others in maximizing the use of online platforms [62]. Therefore, further research on the relationship between these three variables and academic attitude is still needed to map out effective digital learning development strategies.

B. Academic Attitude

Academic attitude is generally defined as the attitude or mental orientation that students have towards learning. This attitude includes belief in the importance of education, motivation to achieve, academic interest, and perception of self-efficacy [8–10, 63]. If students have a positive academic attitude, they tend to show persistence in completing tasks, actively ask questions when experiencing difficulties, and develop effective learning strategies [40]. Strong academic attitude is also associated with better learning engagement, where student welcome academic tasks enthusiastically.

Conversely, a weak academic attitude can demotivate, slow down the learning process, and increase the risk of academic failure. In the digital era, a negative attitude towards online learning can trigger passive behavior or even resistance to technology-based assignments. Therefore, understanding and strengthening academic attitude is an important component in improving the effectiveness of technology-based learning. A strong academic attitude is expected to spur students' full engagement in interactive modules, online discussion forums, and exploration of other digital learning resources.

Many factors influence the formation of academic attitude, ranging from personal characteristics to environmental conditions. A number of studies have shown that basic cognitive ability (general ability) is one of the strongest predictors of positive academic attitude [64]. However, other aspects such as creativity (creative thinking) and leadership ability also have the potential to play a major role, especially in the context of digital learning that requires collaborative approaches and creative problem solving [65]. Thus, studies on the determinants of academic attitude should not ignore the various psychological variables that can interact complexly in the learning process.

In line with this premise, recent research tends to view academic attitude as a dynamic construct, which can be influenced by internal factors such as motivation and external factors such as teacher support or classroom conditions. In the framework of digital technology-based learning, academic attitude can also be colored by students' perceptions of technological sophistication, ease of use, and

relevance of materials presented online. Therefore, technology integration should be accompanied by students' awareness of the benefits and opportunities that can be achieved through digital learning, so that a positive academic attitude is truly formed.

C. General Ability

General ability is often understood as general cognitive capacity (g factor) which includes logical reasoning, problem solving ability, and speed of understanding information [8, 39, 40]. At the primary school level, students with high general ability are generally more flexible in absorbing new academic concepts and applying that knowledge in practical contexts [66]. According to classical intelligence theory, general ability influences academic achievement through information processing mechanisms and learning speed [67]. Students with superior general ability often master subject matter more easily and show stronger academic motivation.

In the context of digital learning, general ability can facilitate adaptation to new technologies. Students who have strong reasoning tend to understand how online learning platforms work and navigate various digital features more easily. When general ability is combined with proper instruction, students can maximize online resources and develop a positive academic attitude. However, high cognitive capacity does not always guarantee a good academic attitude, as there are other factors such as motivation, environmental support and personality that also influence.

Previous studies have highlighted the relationship between general ability and learning outcomes, but not many have specifically highlighted how general ability interacts with other psychological variables such as creativity (creative thinking) and leadership (leadership ability) [68]. In fact, in the digital era, the ability to think creatively and leadership in managing the learning process can be the key to student success in realizing a strong academic attitude. Therefore, research that considers the interaction or mediation and moderation effects of these variables is very relevant to understand the dynamics of learning today.

The role of general ability as the main predictor of academic attitude is also the focus of several hypotheses in this study. It is expected that general ability has a positive and significant correlation with creative thinking (H1), as well as a direct correlation with academic attitude (H2 and H3). Although H2 and H3 appear to duplicate the same effect, the explanation may be more detailed in the methodology or results section, where there are two different pathways or models being tested. What is clear is that the higher the students' general ability, the better their academic attitude, especially when they are exposed to digital technology-based learning.

D. Creative Thinking

Creative thinking refers to the ability to generate new ideas, see problems from multiple perspectives, and be able to combine concepts in unique and original ways [46–49]. In digital classrooms, creativity is needed because students are often faced with tasks and projects that do not have a single answer [17]. They are required to dare to explore, try various approaches, and finally find innovative solutions. In addition, students who think creatively tend to be better able to maintain their motivation to learn because they find the process challenging and interesting.

Many studies have found a positive relationship between creativity and academic achievement, although others have indicated context-dependent results [69]. However, in the digital age, it seems that creative thinking skills are increasingly relevant, especially when students have to utilize various online applications and resources. Students with higher levels of creativity tend to be able to navigate digital platforms more flexibly, design varied learning strategies, and solve technical or conceptual obstacles they encounter.

In relation to this study, creative thinking is proposed to act as a mediator (H6) between general ability and academic attitude. The theoretical assumption is that students with high cognitive ability tend to develop creative thinking more easily, which in turn will encourage a more positive academic attitude. In the scope of digital learning, this is even more important because the presence of technology can open up the widest possible space for creativity, both in terms of producing original work and solving learning problems. Thus, the presence of creativity is expected to be a catalyst that strengthens the impact of general ability on academic attitude.

E. Leadership Ability

Leadership ability in primary school students is often demonstrated through initiatives to lead classmates, the ability to organize group tasks, and effective communication skills [53, 54]. Although still at an early age, the seeds of leadership can already be observed when children are able to influence their peers to stay focused on learning, direct discussions constructively, and make decisions together [70]. The better leadership abilities students have, the greater their potential to drive collaborative learning activities, including in the context of digital technology.

In this study, leadership ability is hypothesized to be a moderator, which moderates the general ability-academic attitude relationship (H7) and the creative thinking-academic attitude relationship (H8). In other words, when students have strong leadership ability, the positive impact of general ability and creative thinking on students' academic attitude will be greater. This can happen because students with leadership encourage themselves and their peers to be more actively involved in the learning process, utilize technology to organize discussions, and maintain group motivation. Leadership ability is also related to the confidence to take a central role, so that the cognitive skills and creativity that already exist can be realized in more tangible academic behavior.

The existence of leadership ability at the primary school level is often overlooked because many people think that leadership only develops in adolescence or adulthood [71]. In fact, leadership potential can be developed from an early age through the habituation of responsibility, providing space for initiative, and teacher guidance in collaborative activities. If implemented consistently, this approach will not only benefit the formation of academic attitude, but also equip students with social skills that are important for their future.

F. Conceptual Framework and Research Hypothesis

The conceptual framework in this study places General

Ability (GA) as an independent variable that affects Academic Attitude (AA). On the one hand, Creative Thinking (CT) serves as a mediator that strengthens the relationship between GA and AA. On the other hand, Leadership Ability (LA) acts as a moderator that affects the strength of the relationship between GA and CT with AA. A more complete conceptual framework can be seen in Fig. 1.

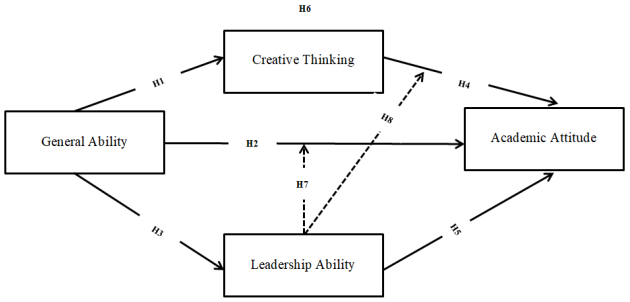

Fig. 1. Theoretical framework.

Through this construct, the research seeks to uncover the complex mechanisms linking general cognitive ability, creativity, leadership, and academic attitude in digital technology-based learning.

The following hypotheses are proposed according to the outline:

H1: There is a positive and significant correlation between General Ability (GA) and Creative Thinking (CT).

H2: There is a positive and significant correlation between General Ability (GA) and Academic Attitude (AA).

H3: There is a positive and significant correlation between General Ability (GA) and Academic Attitude (AA) (contains a different path or model from H2).

H4: There is a positive and significant correlation between Creative Thinking (CT) and Academic Attitude (AA).

H5: There is a positive and significant correlation between Leadership Ability (LA) and Academic Attitude (AA).

H6: Creative thinking (CT) significantly mediates the correlation between General Ability (GA) and Academic Attitude (AA).

H7: Leadership Ability (LA) significantly moderates the correlation of General Ability (GA) with Academic Attitude (AA).

H8: Leadership Ability (LA) significantly moderates the correlation of Creative Thinking (CT) with Academic Attitude (AA).

III. Materials and Methods

A. Data Collection

This study collected online data from elementary school students in Padang City, West Sumatra Province, Indonesia. The sampling procedure combined purposive and random techniques. First, elementary schools were purposively selected based on their consistent use of digital learning platforms (Google Form) as reported by school administrators. Within these schools, students from grades 4 to 6 were randomly selected, with inclusion criteria requiring prior participation in at least one semester of structured digital learning activities, as verified through teacher confirmation. This ensured that participants had adequate exposure to technology-based learning environments relevant to the study. The data collection procedure was carried out by distributing questionnaire links, where each student accessed and filled in the scales provided. In doing so, the research team first coordinated with the school to ensure students' participation in filling out the questionnaire. This online completion model was chosen because it is considered more efficient and relevant to the research context, which is digital technology-based learning. In addition, the online approach facilitates the process of data recapitulation and verification, so that the data obtained is relatively quickly collected and can be processed for further analysis.

B. Research Participants

There were 710 respondents in this study, all of whom were students who participated in digital technology-based learning in their respective elementary schools. The respondent selection technique used purposive random sampling, where the students selected were those who had been accustomed to or were currently undergoing a teaching-learning process involving digital platforms or other online learning applications. This criterion was set to ensure that participants had real experience in utilizing technology as part of the academic process. From a total of 710 respondents, the data collected was confirmed to be complete and ready for further processing, as there were no significant missing values across the research instruments. The demographic distribution of these respondents is presented in Table 1.

Table 1. Demographics of research respondents

Demographics		*N*	Percentage (%)
Students Gender	Male	356	50.14
	Female	354	49.86
Students Age	7–9 years old	376	52.96
	10–12 years old	334	47.04
School Type	Public school	341	48.03
	Private school	369	51.97

C. Research Design

The research design used is quantitative and combines three main analysis methods, namely descriptive statistics, network analysis, and correlation & path analysis. The quantitative approach was chosen to test the hypothesis objectively and measurably, in accordance with the research objectives in explaining the relationship between variables [34]. Through descriptive statistics, this research presents an overview of data distribution, such as mean, standard deviation, minimum, and maximum values. Meanwhile, network analysis aims to map the relationship between indicators in each variable. Finally, correlation & path analysis utilizes the Partial Least Square-Structural Equation Model (PLS-SEM) framework to test the conceptual model and identify the relationship paths between variables according to the hypotheses that have been formulated.

D. Instrument

There are four main instruments used in this study, namely: (1) Academic Attitude Scale, (2) General Ability Scale, (3) Creative Thinking Scale, and (4) Leadership Ability Scale. The Academic Attitude Scale assesses the extent to which students have positive beliefs about the importance of education, academic motivation, interest in learning, and

self-perception (self-efficacy) in learning activities [72]. The General Ability Scale maps students' general cognitive capacity, including reasoning ability, problem solving, and adaptation to new information [73].

Furthermore, the Creative Thinking Scale assesses aspects of fluency, flexibility, originality, and elaboration [74]. Finally, the Leadership Ability Scale measures students' ability to influence others, communicate effectively, make decisions, and demonstrate vision and integrity [75]. Each variable was measured using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The General Ability Scale consisted of 4 items measuring students' reasoning, problem-solving, and information processing. The Creative Thinking Scale included 4 items representing fluency, flexibility, originality, and elaboration. Leadership Ability was assessed using 4 items that captured initiative, coordination, and peer support in group activities. Academic Attitude was measured by 4 items reflecting motivation, responsibility, learning engagement, and goal orientation. The items were distributed proportionally to reflect the multidimensional aspects of each construct. These four instruments are structured in the form of a questionnaire with a rating scale (Likert scale), so that the resulting data is numerical and can be processed with a quantitative statistical approach.

The General Ability and Leadership Ability scales were developed based on theoretical frameworks [22, 53] and refined through a pilot study involving 60 elementary students. Items were constructed to capture essential dimensions and reviewed by three educational psychology experts for content validity. Based on pilot data, all scales achieved Cronbach's alpha values exceeding 0.89, indicating high internal consistency. To minimize self-report bias, participants were assured of their anonymity and encouraged to respond honestly without fear of evaluation. Instructions emphasized that there were no right or wrong answers and that their responses would be used solely for research purposes

All instruments were tested for construct validity and internal consistency prior to the main data collection. Content validity was ensured through expert judgment by three education psychologists. A pilot study involving 60 students from a comparable demographic was conducted to evaluate item clarity and scale reliability. Cronbach's alpha values from the pilot ranged from 0.89 to 0.93 for all four scales, indicating high reliability. While the Academic Attitude and Creative Thinking Scales were adapted from validated instruments in previous studies, the General Ability and Leadership Ability Scales were developed by the authors and refined through iterative testing.

E. Descriptive Statistic

The descriptive statistical results can be seen in Table 2. The descriptive statistic results are presented to provide a brief overview of the variables measured. In the descriptive table (as per the outline), it is noted that all variables have a total valid data of 710 respondents and missing data of 0. The mean value for Academic Attitude (AA) is 15.028 with a standard deviation of 5.274, while Creative Thinking (CT) has a mean of 16.404 with a standard deviation of 4.620. Leadership Ability (LA) recorded the highest mean of 16.814 with a standard deviation of 5.015, while General Ability (GA) recorded a mean of 16.662 with a standard deviation of 5.050. Each variable had a minimum score range of 4–7 and a maximum of 20, indicating that this sample covered a fairly wide variation in students' academic abilities and attitudes. This measurement is the first step in ensuring that the data is spread out in adequate proportion, so that it can proceed to the next stage of analysis.

Table 2. Results of descriptive statistical analysis

	Academic attitude	Creative thinking	Leadership ability	General ability
Valid	710	710	710	710
Missing	0	0	0	0
Mean	15.028	16.404	16.814	16.662
Std. Deviation	5.274	4.620	5.015	5.050
Minimum	4.000	7.000	4.000	4.000
Maximum	20.000	20.000	20.000	20.000

F. Network Analysis

Next, a network analysis was conducted, as shown in Fig. 2.

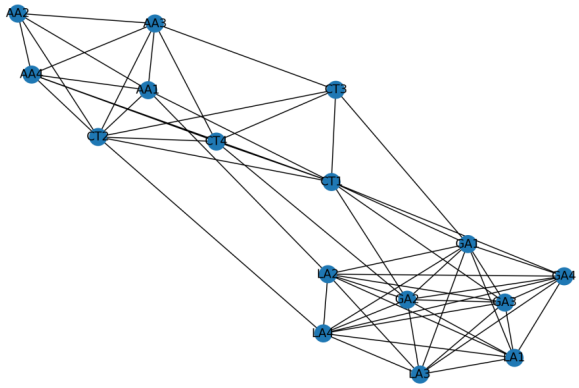

Fig. 2. Network analysis.

One of the methods applied is network analysis, which is useful for mapping the structure of interrelationships between indicators of each variable. Through this method, each indicator (e.g. AA1, AA2, AA3, AA4 for Academic Attitude; GA1, GA2, GA3, GA4 for General Ability; and so on) is displayed as a node in a graph. The edge between two nodes represents the correlation or partial correlation after controlling for other variables. The visualization results (network image) show that indicators within a construct tend to cluster, indicating the internal consistency of each variable. In addition, there are some cross-variable linkages (e.g. between GA and CT, or CT and AA), which further emphasizes the role of creativity and general ability in building positive academic attitudes. Thus, network analysis provides insight into how certain items are closely related to each other and how this may influence the formation of the overall research variable.

G. Correlation and Path Analysis

In addition to network analysis, this research also uses correlation & path analysis based on the Partial Least Square-Structural Equation Model (PLS-SEM) to test the hypotheses and conceptual models that have been formulated. PLS-SEM was chosen because this method is considered appropriate in processing data with a large number of

indicators and has less strict distribution assumptions [76].

The research model combines four main variables: General Ability (GA) as the independent variable, Academic Attitude (AA) as the dependent variable, Creative Thinking (CT) as the mediator, and Leadership Ability (LA) as the moderator. With the path analysis approach in PLS-SEM, researchers can assess the direct contribution of GA to AA, as well as see the extent to which CT mediates the relationship and LA moderates the effects of GA and CT on AA. The model fit statistics supporting this structural configuration are presented in Table 3.

Table 3. Research model fit

	Saturated model	Estimated model
SRMR	0.030	0.075
d_ULS	0.126	0.756
d_G	1.677	2.044
Chi-square	4,801.488	5,131.666
NFI	0.851	0.840

In this analysis, model fit is also taken into account with reference to a number of feasibility indices. One of the main indicators reported is the Standardized Root Mean Square Residual (SRMR), which reflects the level of accuracy of the research model to empirical data. Based on the processing results, the SRMR value of this study is 0.030, which indicates that the model has good fit or good fit [76].

The model's confirmatory power was evaluated using R^2 values, where Academic Attitude (AA) was explained with $R^2 = 0.46$, Creative Thinking (CT) with $R^2 = 0.52$, and Leadership Ability (LA) with $R^2 = 0.33$, indicating moderate to substantial predictive accuracy. Factor loadings for each item exceeded the recommended threshold of 0.70. Bootstrapping with 5,000 subsamples was conducted to test the significance of path coefficients, with t-values above 1.96 indicating statistical significance at $p < 0.05$. All hypothesized paths—except for the moderation of LA on the CT-AA relationship—were found to be statistically significant.

IV. Result and Discussion

A. Outer Model

The purpose of evaluating the outer model is to assess the validity of the variables in the structural model. To evaluate this outer model, convergent and discriminant validity tests are used [76]. In addition, in the outer model evaluation process, the reliability of the variables in the research structural model is also tested [77]. The results of this outer model evaluation can be seen in Fig. 3.

1) Convergent validity

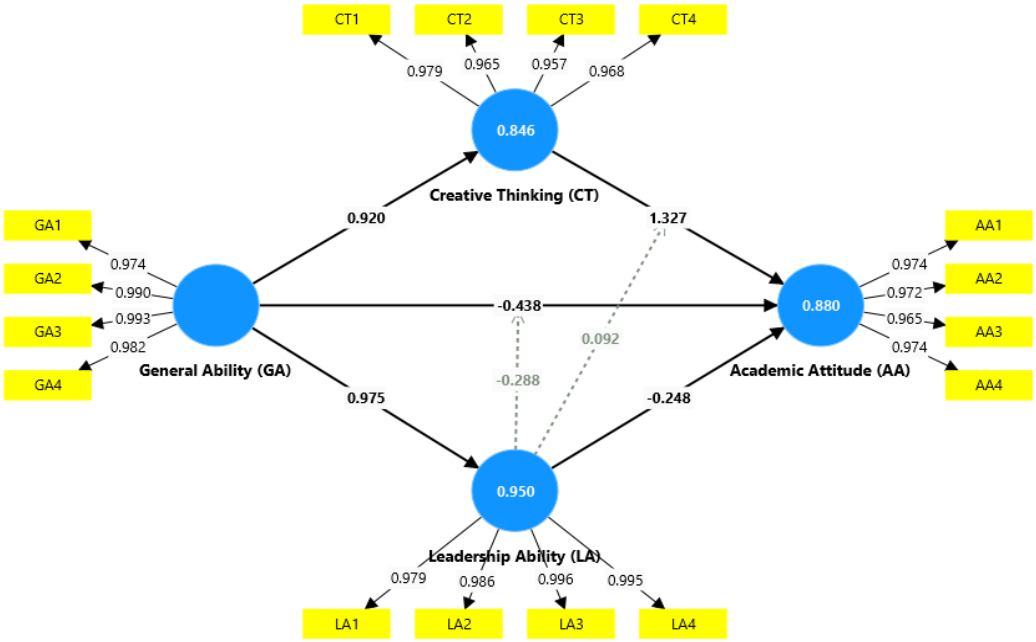

Fig. 3. Results of the research model evaluation.

Table 4. Results of the convergent validity test

	Academic Attitude (AA)	Creative Thinking (CT)	General Ability (GA)	Leadership Ability (LA)
AA1	0.974			
AA2	0.972			
AA3	0.965			
AA4	0.974			
CT1		0.979		
CT2		0.965		
CT3		0.957		
CT4		0.968		
GA1			0.974	
GA2			0.990	
GA3			0.993	
GA4			0.982	
LA1				0.979
LA2				0.986
LA3				0.996
LA4				0.995

The convergent validity test assesses how variable indicators can validly measure the intended construct [77]. Indicators have good convergent validity if the load factor value exceeds 0.7 [76]. The results of this convergent validity test can be seen in Table 4.

Based on the information in Table 4, it is known that each indicator of the research variable has a load factor value greater than 0.7. Therefore, all indicators of each research variable are valid when measuring these constructs.

2) Discriminant validity

The discriminant validity test assesses the differences between variables [76]. Fornell-Lacker criteria were used to test discriminant validity. A variable is considered to have sufficient differentiation from other variables if its loading value differs from other variables' loading values [78]. The results of the discriminant validity test on the research variables can be seen in Table 5.

Based on Table 5, it can be seen that each variable has a different loading value, so it can be concluded that each variable has sufficient differentiation.

Table 5. Discriminant validity results (Fornell-Lacker criteria)

	Academic Attitude (AA)	Creative Thinking (CT)	General Ability (GA)	Leadership Ability (LA)
Academic Attitude (AA)	0.971			
Creative Thinking (CT)	0.929	0.967		
General Ability (GA)	0.838	0.920	0.985	
Leadership Ability (LA)	0.833	0.909	0.975	0.989

3) Reliability assessment

The reliability test of the research variables aims to assess the reliability of the variables in forming the structural model. The Cronbach's alpha value is used to determine the reliability of the research variables. A variable is considered reliable if its Cronbach's alpha value exceeds 0.7 [76]. The results of the reliability test of the research variables can be seen in Table 6.

Table 6. Results of reliability test

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average Variance Extracted (AVE)
Academic Attitude (AA)	0.980	0.981	0.985	0.943
Creative Thinking (CT)	0.977	0.978	0.983	0.936
General Ability (GA)	0.990	0.990	0.992	0.970
Leadership Ability (LA)	0.993	0.993	0.995	0.979

Based on Table 6, it can be seen that all research variables have Cronbach's alpha values above 0.7, which indicates that each variable has good reliability.

B. Inner Model

Inner model evaluation aims to assess the relationship between variables in the research structural model. The internal model evaluation process consists of two stages: hypothesis testing and R-square value analysis [77, 79].

1) R-square

The R-square value analysis aims to assess the concurrent influence of several independent variables on the dependent variable [76]. The results of calculating the R-square value for the research model can be seen in Table 7.

Table 7. Result of R-square

	R-square	R-square adjusted
Academic Attitude (AA)	0.880	0.879
Creative Thinking (CT)	0.846	0.846
Leadership Ability (LA)	0.950	0.950

Based on the R-square table, the R-square value is 0.880 for Academic Attitude (AA), 0.846 for Creative Thinking (CT), and 0.950 for Leadership Ability (LA). This means that 88% of the variation in AA can be explained by the independent variables that influence it, while the remaining 12% is influenced by other factors outside the model. Similarly, 84.6% of the variation in CT can be explained by the related constructs, while the remaining 15.4% comes from other aspects. LA has the highest percentage of explanation, 95%, indicating that the variables in the model have a high predictive power on student leadership ability.

The R^2 value of 0.950 for LA indicates that the model explains 95% of the variance in LA based on the variables included. In the context of elementary digital education, this suggests that students' leadership traits in technology-based learning environments are highly influenced by cognitive and creative factors. It implies that leadership behaviors at this age are not yet independently formed but are shaped by how well students understand tasks and think creatively in group or project-based digital learning scenarios.

2) Hypothesis testing

The research hypothesis is accepted if the t-statistic value is more than 1.96 and the probability value is less than 0.05 or 5% [77, 79]. The results of the research hypothesis test can be seen in Table 8.

The findings align with the broader literature on digital learning environments, where higher general ability and creativity are crucial for navigating technology-rich academic tasks [5, 6]. Digital platforms require students not only to process information but also to apply flexible, creative strategies to maintain engagement and achieve learning goals. Based on the results of hypothesis testing, it can be concluded that H1 (positive relationship between General Ability and Creative Thinking) is proven significant, while H2 (direct relationship between General Ability and Academic Attitude) is not significant. Furthermore, H3 which states the positive effect of General Ability on Leadership Ability is proven significant, as well as H4 (the effect of Creative Thinking on Academic Attitude). However, H5 (the effect of Leadership Ability on Academic Attitude) was not significant. In terms of moderation, H6 (Leadership Ability moderates the effect of General Ability on Academic Attitude) is significant, while H7 (Leadership Ability moderates the relationship between Creative Thinking and

Academic Attitude) is not significant. Finally, H8 which states that Creative Thinking mediates the relationship between General Ability and Academic Attitude was found to be significant, indicating that creativity acts as a crucial link between general ability and academic attitude.

The results of this study generally examine the effect of General Ability (GA), Creative Thinking (CT), and Leadership Ability (LA) on Academic Attitude (AA) in digital technology-based learning at the elementary school level. The findings are represented by eight hypotheses (H1–H8) that include direct effects, mediating effects, and moderating effects. Broadly speaking, this research shows how students' general ability can transform into positive academic attitudes when supported by high levels of creativity, and how leadership can strengthen or neutralize these effects, depending on the relationship pathways involved. The following discussion will elaborate on each hypothesis and how it relates to both theoretical foundations and practical implementation.

Table 8. Results of hypothesis test

	Original Sample (O)	Sample Mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	*P* values	Result
Direct Effect						
General Ability (GA) > Creative Thinking (CT)	0.920	0.920	0.007	141.449	0.000	H1 Accepted
General Ability (GA) > Academic Attitude (AA)	−0.438	−0.399	0.236	1.857	0.063	H2 Rejected
General Ability (GA) > Leadership Ability (LA)	0.975	0.975	0.005	177.951	0.000	H3 Accepted
Creative Thinking (CT) > Academic Attitude (AA)	1.327	1.326	0.087	15.294	0.000	H4 Accepted
Leadership Ability (LA) > Academic Attitude (AA)	−0.248	−0.278	0.179	1.382	0.167	H5 Rejected
Moderating Effect						
Leadership Ability (LA)×General Ability (GA) > Academic Attitude (AA)	−0.288	−0.286	0.044	6.510	0.000	H6 Accepted
Leadership Ability (LA)×Creative Thinking (CT) > Academic Attitude (AA)	0.092	0.096	0.048	1.928	0.054	H7 Rejected
Mediating Effect						
General Ability (GA) > Creative Thinking (CT) > Academic Attitude (AA)	1.220	1.219	0.080	15.170	0.000	H8 Accepted

Starting with H1, the findings show that there is a positive and significant correlation between GA and CT. This means that students with good general cognitive ability tend to have higher creativity. In the context of digital learning, students who have high general ability find it easier to understand instructions, access digital learning resources, and apply logical reasoning when facing academic challenges [80, 81]. These results confirm previous literature that links cognitive capacity with fluency, flexibility, and originality. Strong general ability can facilitate students to come up with alternative ideas, explore technology platforms more widely, and utilize various online learning features. Thus, H1 strengthens the belief that creativity at the primary school level can grow along with the improvement of basic cognitive abilities.

Furthermore, H2, which states that GA has a positive and significant correlation with AA, was not proven. Although GA underlies students' ability to understand the material, its influence on academic attitudes does not necessarily arise if there are no other factors that trigger motivation or interest in learning [82]. This is confirmed when high-ability students may feel bored with tasks that are perceived as less challenging, or less driven to develop positive academic attitudes if they do not find appropriate challenges. This means that good general ability is not a guarantee that students will have a higher academic attitude, especially if the digital technology-based learning process is not balanced with adequate creativity or stimulus. This result is in line with the opinion of several educational experts who emphasize the importance of a holistic approach in fostering academic attitudes, not solely relying on cognitive aspects [83, 84].

In contrast to the findings of H2, H3, which states that GA has a positive and significant correlation with LA, was confirmed. This means that students with a high level of cognitive ability have the potential to more easily develop leadership traits, such as the ability to influence others, communicate effectively, and make decisions [51]. In digital learning, this makes sense as high-ability students are often trusted by teachers and peers to lead group projects or moderate online discussions. They tend to be more dexterous in understanding tasks, creating frameworks and guiding their peers. H3 thus highlights another facet of general ability, the capacity to coordinate collective action. At the primary school level, this leadership potential can be further nurtured if supported by collaborative programs that stimulate student initiative and responsibility.

Moving on to H4, the analysis revealed that CT has a significant positive effect on AA. This suggests that the more creative a student is, the stronger the academic attitude shown. Digital technology-based learning provides space for students to express original ideas, conduct independent searches, and complete tasks with alternative approaches [8, 85]. Creative students find the learning process an exciting challenge, fostering intrinsic motivation. Creativity tends to prevent boredom and fosters greater curiosity, resulting in improved academic attitude. In line with various studies in the field of educational psychology, H4 confirms that creativity is not just a "complement", but a determinant variable that can increase learning engagement and enjoyment of learning among elementary school students [7, 86].

Interestingly, H5, which states a positive and significant correlation between LA and AA, was rejected. In other words, student leadership does not have a direct impact on their academic attitude. This can be interpreted that a student may have a prominent leadership talent-for example, being quick to take initiatives or daring to speak in front of the class-but not necessarily accompanied by deep motivation and interest

in academics [29, 87]. In the context of digital learning, children who are able to "lead" group activities may not necessarily exhibit higher academic attitude if they see their tasks as social obligations or teacher demands rather than an intrinsic drive to learn. This finding underscores the importance of pedagogical approaches that bridge leadership with academic motivation, such as encouraging student leaders to also optimize their own learning outcomes, rather than simply directing others [88].

In the moderation domain, H6 states that LA moderates the GA-AA relationship significantly. This result indicates that in high cognitive ability students, the presence of strong leadership can maximize their potential to be more academically motivated. In contrast to H5 which assesses the direct effect of LA-AA, the moderating effect in H6 shows the important role of LA when interacting with GA. When students with high GA are also equipped with good LA, they are able to focus their learning abilities, motivate themselves and their peers, and direct the digital learning process to be more effective. This finding is in line with the idea that leadership is a "lever" that helps students actualize their cognitive potential in the academic world [89–91]. Thus, H6 illustrates how schools can direct high-ability students into leadership positions, both in collaborative projects and online discussions, to strengthen academic attitudes.

Meanwhile, H7 regarding LA moderation in the CT-AA relationship was not significant. This means that no matter how good a student's leadership ability is, it does not necessarily increase the impact of creativity on academic attitudes [29]. This could be because creativity in elementary school students is more individualized, such as seeking fresh ideas, developing personal solutions, or involving personal interest in a particular topic. Leadership, which often emphasizes group coordination, may not be as crucial in fostering academic enthusiasm born from individual creative thinking [92]. This finding invites us to be more cautious in formulating digital learning programs that seem to equate creativity with leadership. While both can be complementary, there are certain contexts where creativity stands alone and is less influenced by leadership elements. Leadership appears to influence how general ability translates into academic attitudes by shaping students' ability to organize, direct, and apply their cognitive skills in collaborative digital settings. However, it may not significantly affect the link between creativity and academic attitude, as creativity tends to be an internal, individualized process. Elementary students may not yet have the maturity to use leadership to influence others' or even their own creative engagement, especially when tasks are designed to foster independent exploration rather than structured group dynamics. One possible explanation for the non-significant moderation effect of leadership ability on the creative thinking–academic attitude relationship is that creativity in elementary students tends to be an individualized process. Leadership skills, which involve guiding others, may not directly enhance or influence the personal internalization of creative ideas into positive academic behaviors at this developmental stage [36, 87].

Finally, H8, which asserts that CT mediates the relationship between GA and AA, proved to be significant. This result confirms that high GA does not automatically guarantee positive AA, but needs to be transformed through creative thinking skills [93]. The implication is that if schools want to improve students' academic attitude, they need to stimulate creativity, especially among students who have outstanding cognitive abilities. If creativity is neglected, high GA students may not feel sufficiently challenged or inspired, resulting in neutral or even negative academic attitudes. This is relevant in digital learning as online platforms provide wider opportunities for innovation. It is the teacher's job to ensure that the curriculum and teaching methods facilitate creative exploration, encourage students to experiment with different learning formats, and integrate original projects that spur curiosity. Thus, H8 describes an important mechanism: GA needs to be "channeled" through CT to have a real impact on AA.

In terms of implementation, the above findings provide a number of practical insights. First, schools can strengthen creativity development programs as they have been shown to play a role in improving academic attitudes and bridging cognitive abilities. Methods such as project-based learning, problem-based learning, and the integration of interactive digital platforms can be relied upon to foster creativity. Second, General Ability (GA) students should be encouraged to take on leadership roles, as LA has been shown to moderate the GA-AA relationship. This could take the form of appointments as group leaders in digital projects, facilitators of online discussions, or initiators of other technology-based collaborative activities. Third, leadership is not directly related to AA (H5) and does not moderate CT-AA (H7), so teachers and educational policy makers need to design activities that integrate leadership aspects with specific academic goals. Student leadership excellence should not only have an impact on classroom orderliness without contributing to improved academic attitudes. These insignificant results may be influenced by contextual factors such as limited student autonomy in digital tasks, uneven digital literacy, or a curriculum that does not fully support creativity-driven or leadership-driven outcomes. In particular, the non-significant moderation of LA on the CT–AA path (H7) may reflect that leadership skills among elementary students are still emerging and may not yet translate into influence over individual creative expression or internal attitudes toward learning.

Nevertheless, this study has some limitations that should be noted. The online survey using purposive random sampling may reduce the representativeness of the population at large, especially in locations with inadequate infrastructure for digital learning. The measurement of research variables still relies on self-report, which is prone to bias the subject's desire to present themselves more positively. In addition, this study was cross-sectional, making it difficult to ascertain causal relationships. Therefore, further research can adopt a longitudinal design so that the development process of leadership, creativity, and academic attitude can be seen dynamically. A mixed methods approach (e.g. classroom observation, interviews with students, and analysis of their digital projects) is also recommended to deepen the quantitative findings.

Recommendations for future research include expanding the sample and contextualizing digital learning in different regions. Not all schools have stable internet access or sufficient technological devices, so it is necessary to see how

GA, CT and LA variables play a role in more limited infrastructure conditions. In addition, including other variables such as parental support, teacher support, or students' attitude towards technology (e.g. technology acceptance) can enrich the understanding of the dynamics of digital learning. There are also opportunities to explore multivariable moderation and mediation, such as examining whether peer collaboration can moderate the relationship between CT and AA, or to what extent self-efficacy can mediate the relationship between LA and learning outcomes.

In general, this study succeeds in presenting a comprehensive picture of how general ability requires a touch of creativity to have an impact on academic attitude, while leadership ability is able to strengthen the GA-AA correlation but does not moderate CT-AA. The practical implications are clear: digital learning in elementary schools should be designed to facilitate the "processing" of cognitive ability into creativity, while molding high-ability students into effective leaders in the learning process. While not directly impacting AA, leadership can be a catalyst when combined with a certain level of cognitive ability. With appropriate pedagogical interventions and infrastructural support, the transformation towards meaningful digital learning is very much possible.

V. Conclusion

In general, this study found that General Ability (GA) does not have a direct effect on Academic Attitude (AA), but becomes significant when passing Creative Thinking (CT) as a mediator; in other words, cognitive potential must be processed through creativity to produce a positive academic attitude. In addition, Leadership Ability (LA) was shown to moderate the GA-AA relationship, so that students with high general ability will be more motivated to learn if supported by leadership ability. However, LA was not directly related to AA nor did it moderate the CT-AA relationship, indicating that the role of leadership focuses more on the effectiveness of GA to AA transformation rather than enhancing the impact of creativity. This finding confirms the importance of strategically integrating cognitive capacity, creativity and leadership in designing digital learning, especially at the primary school level, to shape more optimal academic attitudes. These findings suggest that digital curriculum designers should integrate project-based learning opportunities that simultaneously stimulate creativity and cultivate leadership skills. Encouraging students to lead digital projects while innovating independently can create a balanced development of cognitive, creative, and collaborative competencies. A longitudinal design could help track how students' creativity and leadership abilities evolve over time and how these changes influence their academic attitudes in digital settings. Meanwhile, a mixed-methods approach could provide deeper insight into the lived experiences and perceptions of students, particularly in understanding why certain relationships (e.g., between creativity and leadership) are not significant. By simultaneously integrating creative thinking as a mediator and leadership ability as a moderator, this study offers a novel framework to understand academic attitude formation in digital learning. Educational stakeholders are encouraged to implement early interventions that foster both creativity and leadership among elementary students to better prepare them for the demands of 21st century learning.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

In this study, Nurhastuti was responsible for conceptualizing the theoretical framework, developing hypotheses, and developing the overall research design. Ade H. Putra played a role in the preparation of measurement instruments, scale validation, and coordination with schools for data collection. Syari Yuliana led the initial data processing, performed data quality checks, and helped prepare the dataset for further analysis. Mardhatillah Zulpiani conducted the main statistical analyses (descriptive statistics, network analysis, and correlation & path analysis), interpreted the findings quantitatively, and compiled the results section. Jehan N. Oktaviani, Tasha D. Putri, and Afdal prepared the first draft of the manuscript, integrated the contributions of the other authors, and performed final editing to ensure coherence, language rigor, and conformity with scientific publication standards. All authors were actively involved in revision discussions, review, and critical appraisal of each section of the manuscript until final agreement was reached. All authors had approved the final version.

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