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Research Artikel

ASSESSING THE DESIGN THINKING MINDSET AMONG ISLAMIC SENIOR HIGH SCHOOL STUDENTS IN DIGITAL TECHNOLOGY PHYSICS TOPICS

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Abstract
Design thinking has emerged as a critical 21st-century competence, yet it remains under-emphasised in Islamic schools, particularly Madrasah Aliyah (Islamic senior high schools). This study investigates the design-thinking mindset of Madrasah Aliyah students studying digital-technology-based physics concepts. Employing a descriptive-correlational design, we used descriptive statistics and Pearson/Spearman correlation analyses to examine relationships among five dimensions of design thinking: (1) Growth Mindset and Endurance, (2) Empathy and Human-Centred Design, (3) Teamwork and Diverse Perspectives, (4) Creativity and Problem-Solving through Prototyping, and (5) Curiosity and Learning Motivation. Data were gathered from 136 students using a validated 25-item questionnaire. Overall mindset levels ranged from moderate to high; Curiosity and Empathy recorded the highest scores, whereas Endurance ranked lowest. Gender- and grade-level comparisons revealed that female students exhibited significantly higher Endurance. Although the cross-sectional design limited insights into developmental trends, a significant negative correlation emerged between Endurance and the other dimensions. These findings highlight the need to balance resilience with curiosity, creativity, and empathy within a design-thinking framework and offer guidance for integrating digital technologies and design-thinking principles into physics instruction while respecting the madrasah cultural context. Future research could explore the impact of interactive digital physics simulations on the development of the five design-thinking dimensions among Madrasah Aliyah students.

Keywords*: Creative mindset; design thinking; digital technology; islamic senior; high school; physics education.*

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INTRODUCTION

The swift evolution of digital technologies has significantly reshaped pedagogical approaches in science education, particularly within the field of physics. The incorporation of advanced tools such as virtual laboratories and augmented reality has fostered more interactive and immersive learning environments, allowing students to explore intricate scientific phenomena beyond the confines of conventional classrooms (Chu et al., 2024). These technological interventions have been shown to improve students' conceptual comprehension, knowledge retention, and applied skills, core competencies essential for thriving in the era of the Fourth Industrial Revolution (Alsharif, 2024; Reeves & Crippen, 2020; Tuli et al., 2022). The widespread implementation of virtual labs during the COVID-19 pandemic further highlights the indispensable function of digital platforms in sustaining educational delivery and enriching the quality of science instruction (Alsharif, 2024).

In the context of Islamic Senior High Schools (Madrasah Aliyah), especially in 12th-grade physics classes, the concept of digital technology in education includes the enhancement of digital literacy, alignment with Islamic values, and the adaptation of pedagogy to modern challenges. Physics instruction is increasingly supported by learning management systems, simulations, and interactive tools that not only aid comprehension but also foster ethical use of technology. This integration is crucial in nurturing both scientific competence and moral awareness among students (Astra et al., 2024; Rizal et al., 2022).

Despite notable technological progress, Islamic Senior High Schools (Madrasah Aliyah) continue to face distinct obstacles in delivering effective physics education. These challenges primarily stem from infrastructural deficiencies, limited pedagogical tools, and prevailing socio-cultural dynamics (Abidin et al., 2024; Jasiah et al., 2024). A significant number of these schools operate without proper laboratory facilities or access to digital instructional media, thereby hindering experiential learning opportunities and diminishing student motivation and participation (Muliandi et al., 2024). Moreover, efforts to harmonize religious educational values with the demands of a flexible and innovative science curriculum present additional complexities, particularly in implementing experiential or inquiry-based pedagogies (Jasiah et al., 2024).

Furthermore, recent developments in educational technology, especially during the pandemic have accelerated the shift toward online and blended learning in Madrasah Aliyah physics classrooms. This shift has underlined the need to improve digital skills among both students and educators, while also addressing issues of equitable access and ethical guidance in digital spaces (Laar et al., 2020).

These intersecting factors have resulted in uneven physics learning outcomes, highlighting the urgent need for context-sensitive instructional strategies that align with the unique characteristics of Islamic educational environments. This study places particular emphasis on the underexplored presence of design thinking mindsets among students in Islamic Senior High Schools, particularly within the context of physics instruction enhanced by digital technology.

The choice of this setting is driven by the unique challenges these schools face, including limited access to resources and digital learning tools, which makes it an under-researched area in the context of STEM education. Design thinking, encompassing creativity, collaboration, and problem-solving, represents a vital cognitive framework for preparing students to address the multifaceted challenges of the digital age and to pursue success in STEM-related disciplines (Amrizaldi et al., 2025; Laar et al., 2020; Parno et al., 2021).

Nevertheless, prevailing instructional approaches in these institutions frequently lack intentional strategies to cultivate such mindsets, thereby potentially impeding students' preparedness for engaging in complex scientific inquiry and fostering innovation (Amrizaldi et al., 2024).

The term design thinking mindset refers to the cognitive and attitudinal traits that enable individuals to approach problems with creativity, empathy, and collaboration, which are core to the design thinking framework. It involves adopting an iterative, user-centered approach to problem-solving, encouraging flexibility, adaptability, and continuous learning. This mindset is fundamental for engaging with complex problems and is essential for developing the skills needed in modern STEM education (Contente & Galvão, 2022).

The design thinking framework is commonly structured around five iterative stages: Empathize, Define, Ideate, Prototype, and Test, each maintaining a user-centered orientation while promoting continuous refinement (Bachri et al., 2021). The Empathize phase focuses on understanding user needs through observation and engagement (Suauthai et al., 2022), Define involves articulating the core problem with clarity and precision (Bachri et al., 2021), Ideate encourages the generation of creative and diverse solutions within collaborative teams (Hatammimi & Andini, 2022), Prototype emphasizes the creation of tangible representations for exploration and improvement (Wiryandhani et al., 2023), and Test entails gathering user feedback to iteratively enhance the proposed solutions (Kumar et al., 2024). This cyclical and collaborative approach fosters adaptive learning and innovation, key components in advancing educational practices (Kumar et al., 2024).

In the context of physics education, the integration of digital tools and simulations has redefined traditional instruction by offering interactive, visually rich, and engaging experiences that promote deeper conceptual understanding and design thinking mindset (Afrilia et al., 2021; Laurenty et al., 2024). For example, platforms like the Motion Dynamics Metaverse allow students to manipulate variables in real time, thereby supporting their grasp of complex and abstract physical phenomena (Laurenty et al., 2024). The incorporation of artificial intelligence assistants, gamification elements, and augmented reality further enhances learner motivation, personalization, and inclusivity (Kotsis, 2024). Digital collaborative environments enable peer-to-peer interaction and stimulate critical thinking, both of which align with the principles of design thinking (Jayapalan et al., 2024), while real-time assessment tools offer data-driven insights to personalize instruction (Rizal et al., 2022).

Design thinking has garnered increasing recognition within STEM education for its capacity to promote experiential, interdisciplinary learning while cultivating a mindset oriented toward creation, testing, and iterative reflection (Thomason & Hsu, 2024). Although its application in physics education is not yet extensively documented, core design thinking principles have demonstrated potential in enhancing students' conceptual understanding and analytical problem-solving abilities in the discipline (Park, 2021). Key challenges in implementation include the need for comprehensive teacher training and curricular adjustments; nevertheless, when executed effectively, design thinking approaches have been associated with heightened student engagement and a reduction in attrition rates (Novo et al., 2023). To fully realize the benefits of design thinking in physics education, it is essential to embed design-based learning projects that provide ongoing feedback and are facilitated by well-prepared educators capable of guiding students through iterative learning cycles (Park, 2021). This pedagogical integration aligns with broader educational goals of cultivating critical

21st-century competencies, including digital literacy, creativity, and critical thinking, thereby equipping students to meet the evolving challenges of STEM fields.

Therefore, this study aims to evaluate the design thinking mindset of Madrasah Aliyah students within the context of digitally supported physics learning and to analyze its variations based on gender and grade level with a focus on three core dimensions: creativity, collaboration, and problem-solving. These three dimensions were selected due to their strong relevance to project-based and simulation-oriented physics activities, as well as their reflection of key 21st-century skills emphasized in science and technology education. The remaining two dimensions, empathy and endurance, were still measured but not prioritized in the analysis of group differences. By examining an educational context that has received limited attention in existing literature, this research is expected to offer valuable insights for developing curricula and instructional strategies tailored to the specific needs of Islamic Senior High Schools.

METHOD

This study utilized a structured questionnaire consisting of 25 items on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) to quantitatively evaluate the design thinking mindset of students at an Islamic Senior High School in Probolinggo. The instrument assessed five core dimensions: Growth Mindset and Resilience, Curiosity and Learning Motivation, Human-Centered Empathy and Design, Team Collaboration and Diverse Perspectives, and Creativity and Problem-Solving through Prototyping. These five dimensions are grounded in the design thinking framework proposed by Vignoli et al. (2023), which emphasizes the interrelated nature of cognitive traits and creative problem-solving in design thinking processes.

Content validity was established through expert panel evaluations. Validity was assessed by three experts in the fields of physics education and digital learning design. These experts evaluated the relevance of the indicators to the concept of design thinking mindset using Aiken's V validity index (Aiken, 1980). The validity index score confirmed the alignment of the indicators with the design thinking framework, ensuring the accuracy and relevance of the instrument in measuring the intended dimensions. Internal consistency was confirmed using Cronbach's Alpha reliability coefficient. The Cronbach's Alpha value for the instrument was 0.82, indicating a high level of reliability. Data were analyzed using SPSS and Python to ensure both statistical rigor and computational flexibility. Python was specifically used for more advanced data analysis techniques, including data cleaning, and performing correlation analysis to explore relationships among the five dimensions of the design thinking mindset.

The study population consisted of 136 participants, including 97 female and 39 male students, enrolled in a digital physics course during the even semester of the 2024/2025 academic year at an Islamic Senior High School in Probolinggo. The course utilized digital platforms such as interactive videos and simulations designed to enhance the learning of physics concepts. The specific digital tools and technologies used included PhET simulations and interactive video lessons. Participants were selected using a purposive sampling technique, where only students who were actively engaged in the course and met specific inclusion criteria were included. The inclusion criteria required participants to be enrolled in the course, to have prior experience with digital learning tools, and to provide informed consent to participate.

The data reveals the distribution of students across various class levels, with 11 A7 having the highest number of students (26 students), followed by 12 IPA 4 (22 students) and 12 IPA 5 (17 students). The remaining classes are 12 IPA 3 (16 students), 12 IPA 1 (14 students), 12 IPA 2 (12 students), and the general 12 IPA class (9 students). This demographic breakdown ensured that participants had relevant experience to provide meaningful insights into the design thinking mindset within the context of digital physics education. Informed consent was obtained from all participants, and the data collection process was closely monitored to uphold principles of anonymity and confidentiality.

Adopting a descriptive quantitative research design, data collection was conducted in a controlled setting under direct supervision by the researcher during the 2024/2025 academic semester. The standardized administration procedures enhanced both the reliability and validity of the responses obtained. Subsequent statistical analyses were performed using SPSS and Python to characterize the design thinking mindset and to examine differences across demographic subgroups. The study evaluated five key indicators of the design thinking mindset, as outlined in Table 1. Participants' responses on the Likert scale served as the basis for computing mean scores and standard deviations for each indicator. These statistical parameters offered a comprehensive depiction of the multifaceted nature of design thinking as it applies to digitally integrated physics education.

Table 1. Measurement Parameters for Design Thinking Mindset Indicators

Parameter No.	Indicator Name	Description / Measurement
1	Growing Mindset and Endurance	Scores based on Likert-scale responses assessing perseverance and growth mindset in facing challenges.
2	Curiosity and Learning Motivation	Scores evaluating students' curiosity and intrinsic motivation to learn.
3	Human-Based Empathy and Design	Scores measuring empathy and design thinking focused on human needs.
4	Teamwork and Diverse Perspectives	Scores assessing collaboration skills and appreciation of diverse viewpoints.
5	Creativity and Prototyping Problem Solving	Scores reflecting creativity and problem-solving through prototyping activities.

Because the study employed purposive sampling, focusing on students who were already engaged in digital learning, the findings may not be generalizable to all Islamic Senior High School students, particularly those without prior exposure to digital platforms. This limitation should be considered when interpreting the results, as the sample may not fully represent the broader student population.

The data analysis procedure encompassed several statistical tests to ensure the robustness and interpretability of the findings. Internal reliability was assessed using Cronbach's Alpha, while the Kolmogorov-Smirnov test was employed to evaluate the normality of data distribution. Levene's test was conducted to confirm the homogeneity of variances across groups. To explore differences in design thinking mindset scores, Independent Samples t-tests were applied for gender comparisons, and one-way ANOVA was used to assess variations across class levels. Additionally, Pearson correlation analysis was conducted to investigate interrelationships among the five dimensions of the design thinking mindset. All inferential tests were performed using a significance threshold of $\alpha = 0.05$.

RESULTS AND DISCUSSION

The evaluation of design thinking mindsets among students at Islamic Senior High Schools encompassed a range of dimensions that represent essential cognitive and collaborative competencies required for effective problem-solving in digitally supported physics education. These dimensions encompass perseverance, empathy, collaboration, creativity, and intellectual curiosity attributes that collectively underpin students' capacity to engage in iterative, user-focused design practices. To offer a detailed representation of students' proficiency across each dimension, descriptive statistical measures including mean values, standard deviations, and score ranges are presented in Table 2.

Tabel 2. Descriptive Statistics of Design Thinking Mindset Dimensions Among Islamic Senior High School Students

Dimensions	Average	Standard Deviation	Value	
			Minimum	Maximum
Growing Mindset and Endurance	1.56	0.53	1.00	3.00
Human-Based Empathy and Design	3.33	0.52	2.00	4.00
Teamwork and Diverse Perspectives	3.23	0.48	1.60	4.00
Creativity and Prototyping Problem Solving	3.16	0.56	1.43	4.00
Curiosity and Learning Motivation	3.28	0.50	1.67	4.00

The assessment of design thinking mindsets among Islamic Senior High School students engaged in digitally supported physics instruction revealed varied outcomes across the five evaluated dimensions. The highest mean score was observed in Human-Centered Empathy and Design (M = 3.33; SD = 0.52), suggesting students demonstrated a strong capacity to understand and respond to user needs. This was closely followed by Curiosity and Learning Motivation (M = 3.28; SD = 0.50), indicating a high level of intrinsic motivation toward learning.

Moderate scores were recorded for Teamwork and Diverse Perspectives (M = 3.23) and Creativity and Problem-Solving through Prototyping (M = 3.16), reflecting students' collaborative engagement and ability to generate solutions through creative experimentation. In contrast, the lowest score was found in Growth Mindset and Endurance (M = 1.56; SD = 0.53), pointing to limited perseverance during iterative design processes.

The observed variability in scores highlights differing levels of student engagement with each design thinking component. These findings underscore the need to reinforce endurance-related competencies to support sustained and reflective problem-solving. Grade-level effects on certain dimensions suggest that development factors may influence the development of design thinking. The dynamic interplay among curiosity, empathy, teamwork, and creativity aligns with established design thinking principles, which advocate for iterative, user-centered, and collaborative problem-solving approaches within digitally mediated STEM education contexts (Bachri et al., 2021; Brown, 2008; Kumar et al., 2024; Murad & Ajlan, 2023).

The findings of this study are in line with previous research, underscoring the pivotal role of empathy and curiosity in the cultivation of design thinking mindsets (Bachri et al., 2021). The high scores observed in Human-Centered Empathy, Curiosity, and Learning Motivation resonate with the work of Murad & Ajlan (2023), who emphasized the capacity of digital learning environments to foster user-focused engagement and stimulate intrinsic motivation. Similarly, the moderate performance in Teamwork and Creativity supports the collaborative and iterative foundations of design thinking (Hatammimi & Andini, 2022).

In contrast, the notably low scores in Growth Mindset and Endurance reflect enduring challenges in STEM education, particularly regarding students' persistence in iterative and trial-based problem-solving (Novo et al., 2023; Nugraha et al., 2024). This limitation may be partially attributed to structural and contextual barriers present in Islamic Senior High Schools, including insufficient infrastructure and limited teacher preparedness (Abidin et al., 2024). The gender-based differences in endurance, with female students demonstrating higher resilience, are consistent with the findings of Thomason & Hsu (2025), indicating potential gender-linked variations in collaborative persistence. By exploring the design thinking mindset within the culturally specific context of Islamic-based STEM education, this study contributes to an emerging body of literature. It emphasizes the interplay between educational environment and mindset development, an area that remains underexamined in the domain of physics education (Park, 2021).

The findings highlight the promise of integrating design thinking methodologies with digital technologies to cultivate key 21st-century competencies, namely, creativity, empathy, and collaboration, among students in Islamic Senior High Schools. Elevated levels of curiosity and empathy suggest that students are well-positioned to engage in user-centered, inquiry-driven learning models, which are essential for achieving deep conceptual understanding in physics (Jayapalan et al., 2024). Nonetheless, the identified deficiency in endurance underscores the importance of pedagogical strategies aimed at building perseverance, such as scaffolded feedback mechanisms and structured opportunities for resilience development within design-based learning activities.

The observed demographic variations further indicate the necessity for differentiated instruction and culturally responsive pedagogy to support equitable mindset development across gender and educational levels. These insights hold practical implications for curriculum design and teacher professional development, particularly in emphasizing holistic digital integration that addresses the specific needs and constraints of Islamic educational settings (Sholeh, 2023). Effectively implementing such approaches has the potential to increase student motivation, decrease attrition, and better prepare learners for the dynamic, interdisciplinary challenges inherent in contemporary STEM education (Nguyệt et al., 2025).

The demographic characteristics of the participants were analyzed to understand their potential impact on the development of the design thinking mindset. Gender, for example, was examined to explore any influence on cognitive and behavioral aspects related to design thinking. The findings indicated variations in mindset development across different demographic groups, with significant insights drawn from the gender proportions shown in Figure 1. These results are important for interpreting the influence of demographic factors on students' engagement with design thinking and the application of related competencies. Figure 1 provides context by depicting the gender distribution within the sample, which helps to understand variations in the development of design thinking dispositions.

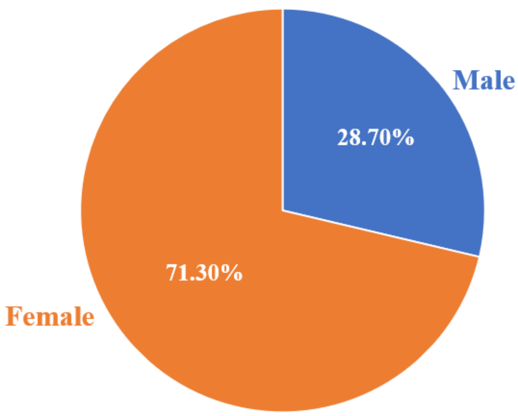

Figure 1. Distribution of Responses by Gender

As illustrated in Figure 1, the sample was predominantly composed of female students, who constituted 71.3% of the total respondents, whereas male participants accounted for 28.7%. This gender distribution provides a critical context for examining differences in design thinking mindsets among students engaged in digitally facilitated physics education. The quantitative data were gathered using a 25-item questionnaire that assessed five principal indicators of the design thinking mindset: growth mindset and endurance, curiosity and learning motivation, human-centered empathy and design, teamwork and diverse perspectives, and creativity and problem-solving through prototyping. These indicators capture the iterative and multidimensional characteristics inherent to the design thinking framework (Svalina et al., 2022). The overrepresentation of female respondents allows for a robust comparative analysis to explore the role of gender in shaping these mindset dimensions.

Prior research has consistently shown that female students are often more actively engaged in creativity and collaboration, two foundational components of the design thinking mindset (Lewis et al., 2020). According to Mayer and Schwemmle (2024) further contend that core aspects of design thinking, such as empathy and iterative refinement, may be experienced differently by male and female learners, shaped by both sociocultural and educational influences. Previous studies also suggest that female students tend to perform more strongly in empathy-based phases of the design thinking process, including Empathize and Teamwork, while male students often demonstrate greater variability in the Ideation and Prototyping stages (Huda et al., 2023). Additionally, the integration of digital technologies into physics education offers interactive and visually rich learning environments that cater to diverse cognitive styles and learner preferences (Afrilia et al., 2021; Kotsis, 2024; Laurenty et al., 2024). The gender disparity within the current sample therefore presents a valuable opportunity to explore nuanced cognitive and affective differences that may influence students' design thinking profiles.

The findings of this study carry significant implications for instructional strategies in Islamic Senior High Schools, particularly as digital technology becomes increasingly embedded within science education frameworks. Recognizing the role of gender in shaping design thinking mindsets can inform the development of inclusive pedagogical practices that enhance learning outcomes for diverse student populations. Educational strategies should capitalize on the demonstrated strengths of female students in empathy, collaboration, and creative problem-solving, while simultaneously implementing targeted interventions to increase male students' engagement and participation (Oliva et al., 2024). Furthermore, scholars such as Kumar et al. (2024) emphasize the pedagogical value of reinforcing iterative stages such as prototyping and testing through digital platforms to promote critical thinking and foster innovation across gender lines. These approaches are especially relevant in addressing systemic educational challenges within Islamic school contexts by cultivating essential 21st-century competencies required for navigating complex scientific and technological domains (Novak & Mulvey, 2020). Figure 2 illustrates the distribution of mean scores across the five design thinking indicators, offering further insight into students' mindset profiles.

As depicted in Figure 2, students exhibited varying degrees of design thinking mindset within the context of digitally mediated physics instruction. The highest average score was recorded for Curiosity and Learning Motivation (M = 3.39), followed by Human-Centered Empathy and Design (M = 3.33), Teamwork and Diverse Perspectives (M = 3.27), and Creativity and Problem-Solving through Prototyping (M = 3.21). The lowest mean was observed in the domain of Growth Mindset and Endurance (M = 1.86), revealing a pronounced disparity in students' capacity for sustained effort and perseverance compared to their relative strengths in empathy, collaboration, and innovation.

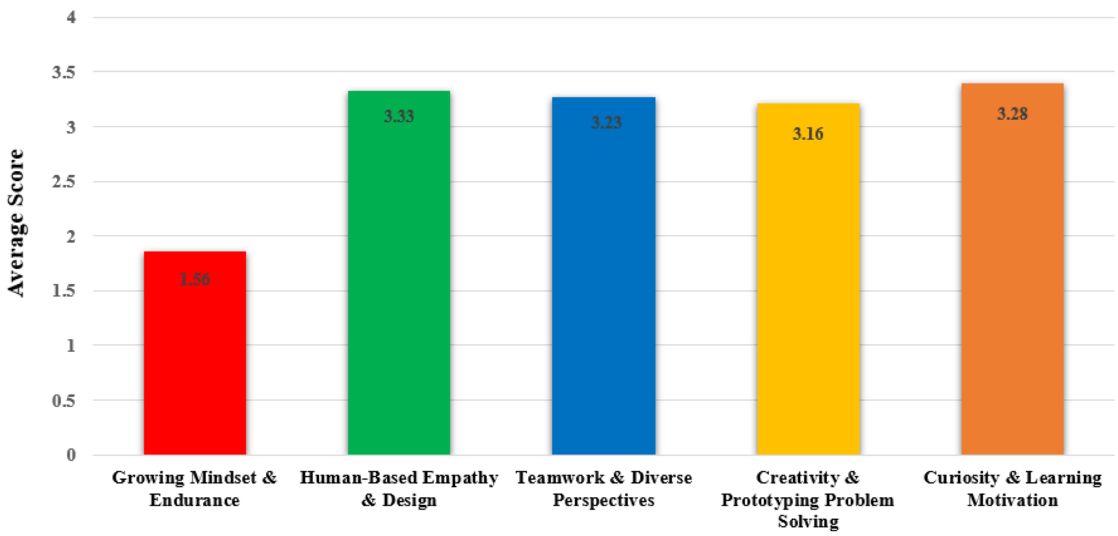

Figure 2. Average Scores of Design Thinking Mindset Indicators

This trend corresponds with previous studies that identify thinking construct empathy, curiosity, and teamwork as foundational elements in the practical application of design thinking (Hatammimi & Andini, 2022). Note that these indicators are strongly associated with the Empathize, Define, and Ideate stages of the design thinking process, where the focus lies in user understanding and idea generation (Bachri et al., 2021). Interactive and visually enriched digital learning environments have been shown to significantly enhance student engagement within these early phases (Afrilia et al., 2021). In contrast, the notably low scores in Endurance underscore persistent difficulties in sustaining effort during the problem-solving process particularly within the prototyping and testing stages that demand iteration and resilience (Meidani et al., 2022).

In light of these findings, physics education initiatives should place greater emphasis on fostering students' perseverance and cultivating a growth-oriented mindset. As suggested by Reeves & Crippen (2020), the use of simulation-based tools, virtual laboratories, and real-time feedback can effectively support iterative learning and motivate students to persist through multiple cycles of problem-solving. Given the strong levels of empathy and intrinsic motivation identified among participants, there is considerable potential for deeper engagement when learning environments are intentionally structured to be supportive and reflective. Accordingly, Manggopa and Kumampung (2023) advocate for the integration of project-based learning models that emphasize sustained effort, iterative feedback, and critical self-evaluation core pedagogical practices aligned with the prototyping and testing phases of design thinking.

Implementing such pedagogical strategies is particularly vital within Islamic educational settings, where innovative instructional methods must be thoughtfully integrated with cultural and institutional values to support the holistic development of students (Nasution et al., 2024). As Mayer and Schwemmle (2024) suggest, fostering a balanced design thinking mindset not only enhances academic achievement in STEM disciplines but also prepares learners with adaptive problem-solving capabilities essential for navigating the complexities of an increasingly technology-driven world. Reinforcing these claims, the statistical findings presented in Table 3 and Table 4 offer empirical validation by demonstrating the reliability of the dataset, identifying significant differences in mindset indicators across gender and educational levels, and revealing substantial interrelations among the various dimensions of the design thinking construct.

Table 3. Statistical Analysis Summary of Design Thinking Mindset Indicators

Test Type	Indicator	Statistic	p-alue	Significance
Assumption Tests	Normality (Kolmogorov-Smirnov)	-	>0.05	Assumption Met
	Homogeneity (Levene's Test)	-	>0.05	Assumption Met
t-test by Gender	Growing Mindset & Endurance	t = 3.25	0.0019	Significant
	Other Indicators	-	>0.05	Not Significant
ANOVA by Class	Growing Mindset & Endurance	F = 6.54	0.012	Significant
	Human-Based Empathy & Design	F = 4.81	0.030	Significant
	Creativity & Prototyping Problem Solving	F = 10.62	0.0014	Significant
	Curiosity & Learning Motivation	F = 7.08	0.009	Significant
	Teamwork & Diverse Perspectives	-	>0.05	Not Significant

Table 4. Pearson Correlation

Test Type	Indicator	Statistic	p-value	Significance
Pearson Correlation	Growing Mindset & Endurance vs Others	r = -0.20 to -0.34	<0.05	Negative Moderate
	Other Indicators Inter-correlations	r = 0.48 to 0.53	<0.001	Positive Moderate-Strong

These demographic details provide important context for understanding the statistical analysis presented in Table 3 and Table 4, which show the influence of gender and class-level differences on the design thinking dimensions.

In Table 3, we present the results of the t-test by Gender and ANOVA by Class. The t-test by Gender revealed a significant difference in the Growth Mindset & Endurance indicator ($t = 3.25$, $p = 0.0019$), with female students demonstrating higher endurance than their male counterparts. However, no significant differences were found for the other indicators across gender.

ANOVA by Class revealed significant grade-level effects on several dimensions, including Growth Mindset & Endurance ($F = 6.54$, $p = 0.012$), Human-Based Empathy & Design ($F = 4.81$, $p = 0.030$), Creativity & Prototyping Problem Solving ($F = 10.62$, $p = 0.0014$), and Curiosity & Learning Motivation ($F = 7.08$, $p = 0.009$), indicating that grade-level variations impact the development of design thinking dispositions. However, no significant difference was found in Teamwork & Diverse Perspectives across grade levels.

In Table 4, we report the Pearson Correlation analysis, which investigates the relationships between Growth Mindset & Endurance and other design thinking dimensions. A moderate negative correlation was observed between Growth Mindset & Endurance and the other indicators ($r = -0.20$ to -0.34, $p < 0.05$), suggesting that increased perseverance is inversely related to other design thinking components such as creativity and problem-solving. In contrast, moderate to strong positive correlations were found among the remaining dimensions ($r = 0.48$ to 0.53, $p < 0.001$), supporting the interconnected nature of these dimensions in the design thinking framework.

The observed gender-based difference in endurance is consistent with prior research linking perseverance and resilience to socio-cultural and educational influences (Mayer & Schwemmle, 2024). In contrast, the absence of significant gender disparities in empathy, creativity, and teamwork corresponds with findings by Eden et al. (2024), which suggest that digital learning environments promote inclusivity and collaboration, potentially mitigating gender-based variations in these competencies.

Grade-level differences observed across several indicators align with developmental frameworks that emphasize the influence of cognitive and emotional maturation on the evolution of design thinking skills (Bachri et al., 2021). Notably, the negative correlations associated with Growth Mindset and Endurance may imply that increased persistence could be inversely related to adaptability or flexibility in creative problem-solving domains. This interpretation warrants further empirical exploration.

Conversely, the positive intercorrelations among empathy, creativity, teamwork, and curiosity underscore their mutually reinforcing roles in cultivating collaborative, innovative learning environments. These dynamics are effectively supported by the integration of digital technologies, including virtual laboratories and immersive simulations, which enhance engagement and deepen learning in STEM contexts (Alsharif, 2024).

The findings of this study underscore the multifaceted challenges involved in cultivating a robust design thinking mindset within Islamic Senior High Schools, particularly in the face of infrastructural limitations and pedagogical constraints (Jasiah et al., 2024). The gender-specific disparity in endurance highlights the necessity for pedagogical strategies that are sensitive to gender dynamics, fostering both persistence and creative expression in equitable ways (Juma'ah et al., 2023). Likewise, the influence of grade level points to the importance of integrating design thinking progressively across the curriculum through developmental scaffolding (Mulyono & Cristy, 2023).

The adoption of advanced digital technologies, such as virtual laboratories, augmented reality applications, and interactive learning platforms, can play a pivotal role in supporting this progression by offering inclusive, engaging, and iterative learning experiences that transcend conventional educational barriers (Chu et al., 2024; Muliandi et al., 2024). In this regard, educational stakeholders and policymakers are encouraged to prioritize strategic investments in teacher professional development and infrastructure enhancement, enabling Islamic Senior High Schools to effectively leverage digital tools. Such initiatives are essential to democratizing access to high-quality physics education and equipping students with the critical 21st-century skills needed to thrive in increasingly complex scientific and technological domains, while remaining grounded in cultural and religious values (Laar et al., 2020; Nasution et al., 2024).

CONCLUSION

This study examined the design thinking mindset of students in Islamic Senior High Schools within the context of digitally integrated physics education. The analysis revealed notable variations across specific dimensions, most prominently Growth Mindset and Endurance, which were significantly influenced by gender and grade level. Reliability testing confirmed the internal consistency of the instrument used to measure the five core dimensions of design thinking. The findings emphasize the importance of promoting empathy, creativity, and collaboration through innovative pedagogical strategies that incorporate digital technologies. Therefore, the integration of project-based learning models and iterative feedback into the physics curriculum of Islamic Senior High Schools is highly recommended.

Despite existing challenges related to infrastructure and teacher preparedness in Islamic educational environments, the study demonstrates the promising role of design thinking in enhancing student engagement, fostering adaptive problem-solving skills, and preparing learners for the demands of the digital age. These insights enrich the existing literature on 21st-century skill development and advocate for the integration of design thinking frameworks into STEM curricula, particularly physics education, within culturally diverse educational contexts. Future research could explore the impact of interactive digital physics simulations on the development of the five design-thinking dimensions among Madrasah Aliyah students. Such studies may also consider how different types of simulations, such as augmented reality, real-time data visualizations, or gamified modules, uniquely support creativity, empathy, and problem-solving in Islamic educational contexts.

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