

Digital Learning Games and Cognitive Skills of Senior High School Students

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Abstract: This study delves into the impact of digital learning games on the cognitive abilities of Senior High School STEM students at a Metro-Pacific Healthcare Educational Institution. Employing an Exploratory sequential mixed methods design, the investigation comprises 318 quantitative phase respondents and 10 qualitative phase participants from both Grade 11 and Grade 12, selected through purposive sampling. Utilizing statistical measures such as mean, standard deviation, and Pearson correlation coefficient in the quantitative phase and Braun & Clarke thematic analysis for the qualitative phase, the study reveals a substantial positive influence of digital game-based learning on student motivation. The findings underscore the significance of integrating digital learning games into the curriculum, emphasizing their alignment with lesson themes. This strategic integration enhances student engagement and effectively addresses challenging areas. Educators are encouraged to leverage these games as tools for efficient oversight of student progress. The study advocates for a proactive approach, urging teachers to incorporate technology in education to cultivate a positive impact on student motivation and overall learning experiences. By integrating digital learning games into teaching practices, educators can tailor lessons to specific themes, fostering a dynamic learning environment. This research highlights the potential for technology to enhance educational outcomes, providing valuable insights into leveraging digital tools for effective STEM education in Senior High School settings.

Keywords: *Digital learning games, Cognitive skills, mixed method study, explanatory sequential mixed method study, Senior High school students, range of means, educational games, revised bloom's taxonomy*

I. Introduction

Advancements in technology have led educational institutions to utilize and integrate them into students' learning. Computers are now essential in schools, enhancing both the teaching and learning process, while the internet is a valuable tool used regularly by both educators and students (Egemen, 2018). One such integration are educational games, which are tools that foster engagement and provide interactive learning experiences. These games employ visuals, sound, and color to promote player engagement and are further designed to seize the user's complete attention (Adipat, 2021). Further studies about the utilization of this educational tool has been suggested due to its interactivity, and has been known to improve the students' learning (Serrano, 2019).

Majuri *et al.* (2019) advises that future studies be undertaken on a broader scale, and that immersion and social factors be included.

A study by Lamrani and Abdelwahed (2020) examines how the cognitive skills of children are improved through gamification or game-based learning. It was noticed how traditional learning lacks the ability to attract the attention of learners, which discourages them from retaining information. The results of the study suggest that students are more autonomous, confident, and interested in acquiring new social aptitudes and academic skills through game-based learning. A study conducted by Yang *et al.* (2022) examines the students' behavioral patterns after playing a computer-based physics game. It was observed that challenges in games that exceed the capabilities of students may result in

frustration and quitting behaviors without instructional videos for support. Practical implications underscore that instructional videos can improve game performance, and in-game supports should adapt to difficulty levels without imposing restrictions. Additionally, Hur (2023) stated that a challenge for game-based learning would be to align difficulty with student levels and that it's crucial to develop games that cater to diverse student interests to maximize the effectiveness of learning.

In a study by Sumandal (2022), in the Philippines, he observed that students have low motivation and negative attitudes towards science subjects, which led to bad performances of high school students. It is argued that while traditional learning can still be effective, utilizing modern technology is a necessity to develop cognitive potential among students. The results of the study suggest a significant difference in the performances of students before and after using interactive games as a teaching intervention. As presented in the study of Culajara (2023), it was revealed that the integration of game-based approaches in learning has a significant impact on their ability to grasp new skills. A game-based approach is a great tool to integrate in the curricula to further enhance adaptability and flexibility of students when learning. In addition, a study by Tinambunan & Orongan (2019) discovered that the utilization of game-based learning in classrooms resulted in a positive improvement in the level of motivation when learning including an improvement in achievement.

Locally, a study by Lascuna *et al.* (2021), closely relevant to this study on the relationship between digital learning games and cognitive skills among senior high students, the researchers delve into the perceptions and learning attitudes of senior high students at St. Mary's College of Bansalan, Inc. In the specific local context of this study, educational games play a crucial role in shaping how students learn. Despite reservations in the educational community about integrating digital games into classrooms, the research aims to reveal that digital learning games significantly enhance students' cognitive skills. The researchers are affiliated with the Metro Pacific Healthcare educational institution, and it has been observed that senior high school students utilize digital learning games, providing an engaging and interactive way for students to develop and strengthen their cognitive skills. Furthermore, these games allow students to apply their knowledge in an interactive and strategic way, helping them to retain information more effectively. The use of educational games also encourages students to take ownership of their learning, as they can track their progress and identify areas where they need to improve. With the help of this, students are able to ensure and enhance their academic capabilities and skills.

Based on the previous several studies mentioned, digital learning games have positively impacted senior high school students. However, these studies have not thoroughly investigated the relationship between digital learning games and cognitive skills including understanding, analyzing, creating, etc. This research aims to determine if a significant relationship exists between using digital learning games and developing these specific cognitive skills among senior high school students. The findings from this study may contribute to the existing body of knowledge, shedding light on the potential of digital learning games to enhance students' learning outcomes and better prepare them for future academic and professional pursuits.

II. Methods

This research employed a descriptive-correlational research design. Research design is a blueprint that outlines how a study will proceed, from the research purpose and questions through the outcomes. It is a thorough planning procedure used to collect and evaluate data to understand a particular topic (Abutabenjeh & Jaradat, 2018). In this study, the researchers used a descriptive correlational research design to describe and determine the relationship between digital learning games and cognitive skills. To define descriptive correlational as a research method, Creswell (2012; as cited by Javar & Ibojo, 2023) stated that in descriptive correlational design, the researcher had an interest in how much two variables (or more) co-vary, that is, where alterations in one variable result in alterations to the other. The aim of this research design is to fully describe the variables and their relationships without changing them or assuming that one thing causes another (Bhat, 2023).

Through this method, the researchers assessed the level of digital learning games in terms of the student's motivation, attitude, cognitive development, game interface, and expectation. Furthermore, the researchers assessed the level of cognitive skills of senior high school students. As this research goes through the process of assessing the levels of the variables, the researchers will then test if there is a significant relationship between digital learning games and cognitive skills among senior high school STEM students.

This study was conducted in a healthcare educational institution at General Malvar St., Davao City, established in 1975. The institutions offer quality education by promoting their core value, "LIFE," which stands for Liberty, Integrity, Fortitude, and Excellence for senior high school, undergraduate, and postgraduate degrees. However, the study mainly focused on the senior high school program to determine the relationship between educational game learning and cognitive

skills since the institution promoted innovative schools that offer students online and blended learning during the pandemic and up until now. The school continuously upgrades its ways of acquiring knowledge that are accessible and flexible to its employees, students, and administrators.

The chosen method for respondent selection is purposive sampling. This approach is used as the participants have demonstrated a willingness to share their knowledge and experiences, contributing to the study's objectives. Purposive sampling, also known as judgmental sampling, depends on the researcher's judgment to determine which people, situations, or events will yield the most information to meet the goals of the study. (Nikolopoulou, 2023). Purposive sampling is a non-probability sampling that involves selecting responders you believe has strong previous knowledge or a strong interest for the study. The target population's opinions are likely to be acquired through a purposeful sample, but more easily accessible subgroups inside the population are also likely to have more weight (Oribhabor & Anyanwu, 2019). Before proceeding to the actual survey questions, the study included screening questions to determine whether respondents qualify or are disqualified based on their responses. To get clear and generalizable outcomes, the researchers meticulously define the population in their samples. (Noor *et al.*, 2022). Furthermore, the research involved a total of 318 student respondents, specifically drawn from both the grade 11 and grade 12 STEM programs at a Healthcare Educational Institution. This diverse participant pool will provide valuable insights into the topic under investigation, given their varied educational backgrounds and experiences. Slovin's formula was applied to calculate the sample size.

Survey questionnaire is used as the research instrument. It is a research method utilized to acquire information and insights on various topics of interest by collecting data from a pre-defined group of participants. A questionnaire is a set of questions designed to gather valuable data from participants, which is a research instrument (Cint, 2022). These tools have an interview-style format and contain both written and spoken questions. Additionally, surveys are a flexible method for collecting data in various fields, particularly when exploring the preferences, viewpoints, or beliefs of a specific group (McCombes, 2023). In quantitative surveys, the same set of questions, typically accompanied by predetermined response options for selection, is administered (Hellevik, 2019). In this research, the survey was conducted online using Google Forms. The survey questionnaire was distributed to respondents to gather data concerning two key aspects: a.) the level of digital learning games, and b.) the level of cognitive skills among the respondents. The information gathered from the respondents' data will not be disclosed and will only be utilized to draw conclusions for the research.

This research employed an adapted questionnaire from a different study. The first questionnaire, derived from Ibrahim *et al.*'s (2011) work, focused on digital learning games, including aspects like student motivation, attitude, cognitive development, game interface, and expectations. This questionnaire consists of 20 questions and can typically be completed in 10-20 minutes using Google Forms. A second questionnaire has been developed to evaluate cognitive skills. It consists of 30 questions, with 5 questions allocated to each of the following indicators: remember, understand, apply, analyze, evaluate, and create. Respondents used a Likert scale to respond to these questions, and it typically takes approximately 15-25 minutes to complete. In total, this adapted survey questionnaire, combined with the newly developed one, will consist of 50 questions. It is expected that respondents should be able to complete these questions in a maximum time of 35 minutes.

The type of survey questionnaire that is used is a Likert scale. According to Bhandari and Nikolopoulou (2020), it is a rating system employed for evaluating opinions, attitudes, or behaviors. This scale consists of a statement or question, followed by response options, allowing respondents to choose the one that best reflects their stance on the statement or question. Typically, a five or seven-point scale is used to assess an individual's level of agreement or disagreement with a specific statement. This scale provides respondents with options to express their degree of agreement or feeling regarding the question or statement, spanning from positive to negative (McLeod, 2022). In this study, a 5-point agreement scale was utilized. A 5-point Likert scale, as described by Khandelwal (2021), is a psychometric response method that enables respondents to answer questions and convey their agreement level using a five-point scale. It includes five options: 1 for "strongly disagree," 2 for "disagree," 3 for "neutral" (neither agree nor disagree), 4 for "agree," and 5 for "strongly agree."

The following are the statistical tools that the researchers utilized in the computation and interpretation of the data in this study.

Mean and Standard Deviation. In our research on how educational games impact learning skills among Senior High School STEM students, the mean and standard deviation are crucial tools. The mean helped the researchers find the average scores, showing the typical values for things like motivation and cognitive development. Meanwhile, the standard

deviation tells how much individual scores vary from these averages. For instance, if scores on cognitive skills have a small standard deviation, it means most students are scoring similarly. If it's larger, scores vary more. These measures helped the researchers understand overall trends and variations in students' experiences with educational games and their learning skills.

Pearson-r. This statistical tool answered the question about the significant relationship, and quantify the strength of connections between two variables, answering questions about the significance of these relationships. *Pearson's r* helped determine the meaningful correlation between the use of digital learning games and the level of cognitive skills among Senior High School STEM students.

Thematic Analysis. This statistical tool is utilized by the researchers to identify, examine, and explain the data gathered. Furthermore, findings can be accurate and trustworthy if thematic analysis is used precisely. The researchers will specifically use Braun and Clarke's thematic analysis which involves six (6) steps to identify themes and will be used to interpret the data collected in this study.

III. Results and Discussion

Table 1. Summary of the Level of Digital Learning Game Efficiency of Senior High School STEM Students

Indicators	Mean	Std. Deviation	Descriptive Level
Student's Motivation	4.22	0.83	Very High
Student's Attitude	4.36	0.75	Very High
Game Interface	4.09	0.81	High
Students' Expectations	4.16	0.79	High
Overall	4.21	0.80	Very High

As presented in Table 1, senior high school STEM students attained an overall mean efficiency of 4.21 in Digital Learning Games, indicating a very high level. This suggests that these students have demonstrated a strong ability and proficiency in utilizing digital learning games as a tool for their educational advancement. The high mean efficiency score of 4.21 implies that these students are adept at effectively leveraging digital learning games to supplement their education.

It implies that these Digital Educational Games create an interactive learning setting where learners engage with game elements in a virtual space, boosting their motivation to learn, promoting understanding (Gui et al., 2023). Overall, utilizing games for learning has been discovered to enhance the educational experience by making it more engaging, inspiring, and productive for students (Cheung and Ng, 2021).

Specifically, within the domain of digital learning games efficiency, Student's Motivation registers a mean score of 4.22, described as very high. This measurement indicates students possess a robust drive and enthusiasm when engaging with digital learning games. The outcome suggests that the students' high motivation stems from various external factors, particularly the impact of regular feedback from teachers, which positively influences their motivation to learn.

Additionally, setting and striving to achieve goals, feeling motivated to learn and excel academically, and engaging in collaborative group work are key aspects that contribute to their motivation. These findings emphasize that employing digital learning games moderately can positively affect student engagement, motivation, and academic performance. Game-based learning integrates gaming elements and principles into educational tasks, fostering student participation and enthusiasm to learn (Nadeem et al., 2023).

As a result, based on the study of Serrano (2019), there is evidence indicating that digital game-based learning has a considerable impact on student motivation. The research highlights that students engaged in digital game-based learning exhibited notably higher levels of motivation. These findings strongly imply that digital games possess the

capacity to inspire and stimulate students, prompting them to actively participate in their learning, consequently resulting in improved learning outcomes.

To further describe the results, the second indicator, student attitude, has the highest mean score of 4.36 or is described as very high, which means that students generally have a positive attitude towards digital game learning. The mean score indicates that the majority of students have a favorable opinion of using digital games as an educational tool.

The above results align with Xie (2021) study, in which students may perceive digital game learning as an engaging and effective method of learning. Students likely find it enjoyable and believe that it enhances their understanding and retention of academic concepts. This positive attitude could be attributed to the interactive and immersive nature of digital games, which can make the learning process more enjoyable and stimulating.

Additionally, they may see it as a way to supplement classroom instructions, providing an alternative approach that can cater to different learning styles and preferences. Students might appreciate the flexibility and autonomy that digital game learning offers, allowing them to learn at their own pace and explore topics in a more interactive and personalized manner.

Moreover, in the study of Sabirli (2020), the moderate positive attitude could be indicative of several factors. It is possible that students appreciate the interactive and engaging nature of digital game learning, finding it to be a refreshing departure from traditional teaching methods. They may find digital games particularly beneficial for subjects that lend themselves well to interactive and experiential learning, such as science and mathematics.

Furthermore, among the four indicators, Game Interface is rated with a mean score of 4.09 which makes it the lowest rated indicator, although it is still described as high. This outcome shows that Game Interface is evident in the efficiency of digital game learning. This measurement indicates that the students find game interfaces to be productive in assisting with digital game learning. This result is aligned with Gui *et al.* (2023) which showed how the extra learning mechanisms of instructional games help students improve their skills. The learning development of the students is based on the interface of the learning mechanisms (i.e., concept maps and feedback), which is a component of learning content and gaming mechanics (i.e., points and leaderboards), which are intended to boost entertainment value.

In addition, a positive outlook on game interfaces positively contributes to the students' learning experiences in digital gaming, further improving its effectiveness. Important factors to be considered in game interfaces should be user-friendliness, ease of navigation, and a visually appealing design in order for digital game learning to be more productive and efficient. These findings highlight that having a well-designed game interface is necessary to improve the overall learning experience, including engagement and performance. In the study of Ariffin & Shukri (2020), it was found that good usability will make the game more interesting and provide students with a better overall experience. This result is aligned with the results of the study of Zuo *et al.* (2022), implying that the richness of the imaginative scenario of game interfaces play a central role in providing immersive learning environments.

Within the domain of digital learning games, Student's Expectations received a mean score of 4.16, described as high. This suggests that students hold substantial expectations and hopes specifically associated with their engagement in digital learning games. They envision these games as valuable tools that enhance their learning, making lessons more captivating and improving their grasp of educational learnings.

A high mean score in student expectations within this context implies several aspects. Initially, students anticipate that the games will be more interactive and engaging, thereby facilitating efficient learning. Additionally, their expectations indicate a desire for these digital learning games to be accessible through web platforms. Furthermore, their interest lies in gaining comprehensive knowledge in various computer-related disciplines, favoring this method over others. Lastly, they foresee more opportunities to engage in educational game activities, indicating elevated expectations from these learning tools.

Thus, students anticipate that digital games will enhance learning by fostering interactivity, enabling active participation, and facilitating the practical and engaging application of knowledge. In the study of Hernandez & Lopez (2018), students have reasonable expectations regarding the educational value of digital game learning. Students expect that digital games will enhance their ability to gain and retain knowledge, cultivate problem-solving abilities, and enhance their overall academic achievement. Meeting student expectations is critical since it has been indicated that if student expectations are not fulfilled, participation, achievement, and satisfaction decline (Tomlinson *et al.*, 2023)

Table 2. Summary of the Level of Cognitive Skills of Senior High School STEM Students

Indicators	Mean	Std. Deviation	Descriptive Level
Remembering	3.69	0.80	High
Understanding	3.82	0.82	High
Applying	3.62	0.84	High
Analyzing	3.71	0.80	High
Evaluating	3.85	0.85	High
Creating	3.71	0.92	High
Overall	3.73	1.01	High

As indicated by Table 2, the comprehensive mean rating of senior high school STEM students' cognitive skills is 3.73, denoted as high. This outcome suggests that these students excel in the cognitive domain, showcasing robust cognitive abilities. The elevated overall mean implies strong academic performance or a high level of cognitive development among these learners.

This finding aligns with the insights from the study by Anders Ericsson and Oliver (2019), where the cognitive stage is characterized as the initial phase of learning. During this stage, individuals focus on understanding tasks but may occasionally make mistakes due to incomplete comprehension and a lack of full grasp of certain aspects. Therefore, cognitive skills are deemed essential for executing various tasks, whether complex or simple, playing a crucial role in performing activities of varying difficulty levels (Jasper, 2022).

As presented in Table 2, the first indicator "Remembering" gets an average mean of 3.69 or is described as high, which means that students typically excel in recalling facts, information, or concepts, showcasing their proficiency in memorization. This competence extends to retrieving and recognizing previously learned material, involving activities such as recitation and recalling past events, information, or experiences (Kamlasi & Sahan, 2018).

Additionally, Shabatura (2020) supports that remembering serves as a crucial foundation for higher-order cognitive skills, establishing the necessary knowledge base for understanding, applying, analyzing, evaluating, and creating. The act of remembering not only shapes individual and collective identities but also forms the cognitive framework. It enables learners to engage in critical thinking and manage intricate facts and ideas. This dynamic interaction among memory, learning, and shared history plays a pivotal role in the development and application of cognitive skills (Mahr & Csibra, 2020).

To further describe the results, the second indicator, "Understanding," received a mean score of 3.82 or is described as high. This signifies that learners generally attain the cognitive ability to grasp complex information and concepts, engaging in higher-level or advanced cognitive processes that require active thinking. In a study by Lakshmi & Sakthivel (2023), understanding goes beyond mere memorization. Students are tasked to hold a wide range of information, organization of concepts, and expression of ideas through their own interpretation or understanding. With this, students are able to better comprehend the subject matter in which it also enhances their critical thinking and knowledge retention.

Moreover, as highlighted by Ruhl (2023), elucidating ideas or concepts is a fundamental aspect of human cognition, enabling students to effectively internalize and comprehend content. As a result, this process not only enhances critical thinking and knowledge retention but also empowers students to synthesize knowledge, identify patterns, and make connections across various domains, contributing to a deeper and more comprehensive understanding of the world (Shabatura, 2023). This cognitive process effectively cultivates analytical skills and promotes academic growth among learners.

On the other hand, the “applying” indicator is the lowest rated indicator, having a mean of 3.62, but is still classified as high in the descriptive equivalent. The outcome suggests that the students are able to comprehend the materials and resources that they learned, which they then utilize in new and concrete situations that they encounter. The results are aligned with the study of Fastiggi (2023) who mentioned that this is an essential aspect of education as it strengthens the understanding of the students as they grasp the learned information by practical application, in which students develop into more adept problem solvers and critical thinkers, prepared for their lives.

In addition to this, Valamis (2023) pointed out that this goes beyond simply memorizing information; previously acquired concrete and abstract knowledge is required in applying it to situations involving cognitive processes. Moreover, as stated by Lakshmi and Sakthivel (2023), challenging students to use their gained knowledge through a hands-on approach to education enables them to adapt to various circumstances and provides them with a practical grasp of the subject. The findings indicate that cognitive skills empower students to comprehend and think, encouraging them to adopt a pragmatic approach to learning.

Additionally, the mean score of the fourth indicator “Analyzing” is 3.71 described as high. This outcome indicates that students engage in active study or examination of a subject matter, utilizing their cognitive skills to discover and comprehend more about it, thereby establishing the groundwork for effective analysis. It is consistent with the findings of Kuncoro et al. (2022) in which they highlighted the involvement of critical thinking, evaluating evidence, and reaching informed conclusions of students. This thoroughly explores and deconstructs complex information into its fundamental components, going beyond the cognitive level of mere memorization, signifying that analysis involves a deeper and more thoughtful consideration of a topic.

This is also in accordance with the existing research by Valamis (2023), which underscores the crucial role of analysis in the learning process. Students dissect and investigate knowledge by examining connections and developing a deeper understanding by breaking down complex information and structurally and meaningfully organizing it to better comprehend it, guided by specific processes of distinguishing, arranging, and assigning. Furthermore, analysis is an intricate procedure that involves more than just observation. It includes understanding relationships, recognizing organizational principles, and engaging in evaluative judgments, all of which contribute to a more profound comprehension of the material (DaCosta *et al.*, 2021). Overall, the findings suggest a positive trajectory in students' analytical skills.

With a mean score of 3.85 and a standard deviation of 0.85, the fifth indicator, "Evaluating," indicates that the assessment is classified as high based on the descriptive equivalent. This high mean indicates an overall high standard of performance when assessing ideas and data according to all evaluated criteria. These results are consistent with perspectives from Tuma & Nassar (2021), Malik (2019), and Arlianty et al. (2018), who contend that evaluation goes beyond understanding. Students are encouraged to make well-informed choices by offering interpretations that are supported by logic and facts. Because of this cognitive engagement, students are better able to think critically, navigate complex material with ease, and participate actively in discussions and debates.

Moreover, as stressed by Malik (2019), encouraging ethical academic practices depends critically on one's capacity to assess concepts and data. To retain their intellectual integrity, students need to be able to tell the difference between their own and other people's ideas. As a result, developing students' assessment abilities fosters moral principles in addition to improving academic achievement. The results of the survey highlight participants' excellent performance in evaluating skills, which points to a strong basis in critical thinking and decision-making.

Furthermore, in its descriptive equivalent, the "Creating" indicator is categorized as high with a mean score of 3.71 and a standard deviation of 0.92. This implies that respondents fared well in tasks involving creativity overall. The overall trend shows a high level of engagement in creating activities, despite some variation in responses, underscoring the importance of this element.

According to Chandio (2021), being creative boosts intellectual growth by helping one remember and analyze facts. It also fosters cooperation, idea sharing, and teamwork. Giving students the chance to come up with their own solutions and ideas promotes creativity and the investigation of novel ideas. Students are encouraged to engage in activities that spark novel ideas and solutions in this setting, which develops their capacity for critical thought, problem-solving, and collaboration. All in all, this points to a nurturing learning environment that fosters students' creativity and intellectual growth.

Table 3. The Significance on the Association Between Digital Learning Games and Cognitive Skills of Senior High School Students

Cognitive Skills of Senior High School Students				
Digital Learning Games	r	p-value	Decision on H ₀	Interpretation
	.636	.000	Reject	Significant

As presented in Table 3, there is a significant correlation between the respondents' cognitive skills and their use of digital learning games, based on the results provided in Table 5. The correlation between senior high school students' cognitive skills and digital learning games is significant ($p=.000$, $r=.636$), with a P-value of .000, less than .5. As a result, the alternative hypothesis is accepted and the null hypothesis is rejected. The researchers claim that digital learning games could assist in senior high school students' development of cognitive skills based on the results mentioned earlier. The strong correlation suggests that senior high school students' development of cognitive skills is influenced by digital learning games.

There is a significant correlation between the respondents' cognitive skills and their use of digital learning games, based on the results provided in Table 3. The correlation between senior high school students' cognitive skills and digital learning games is significant ($p=.000$, $r=.636$), with a P-value of .000, less than .50. As a result, the alternative hypothesis is accepted and the null hypothesis is rejected. The researchers claim that digital learning games could assist in senior high school students' development of cognitive skills based on the results mentioned earlier. The strong correlation suggests that senior high school students' development of cognitive skills is influenced by digital learning games.

Furthermore, there is a significant association between students' usage of online learning games and the enhancement of their cognitive abilities. There is an excellent possibility that students are using digital learning games to enhance their cognitive capacities. A study carried out by Chimpz (2021) underscores the evolving nature of education, as it increasingly integrates gaming concepts. As modern technology advances, an array of applications emerges to facilitate the dissemination of knowledge.

This is supported by a study conducted by Chang and Yeh (2021), that students have the chance to support the notion that combining computer games with educational objectives enhances the learning process and fosters motivation while offering engaging and creative learning opportunities. Additionally, the use of game-based learning gives students the chance to engage in a distinctive teaching approach that promotes increased participation and energy in class. According to the study by Mocketar *et al.*, (2021), students can actively participate in experiential learning, embrace a willingness to take chances and obtain information within this framework without worrying about facing unfavorable real-world repercussions.

In fact, Wan Azli *et al.* (2018), concluded in their study that students' engagement with mobile games raises their level of satisfaction with their educational experience. Including gaming components is essential for fostering increased motivation, curiosity, and involvement in students. Thus, this demonstrates the benefits of incorporating elements and acknowledges them as useful instruments for raising student motivation, satisfaction, and learning objectives.

The results and discussion section synthesizes key findings regarding senior high school STEM students' efficiency levels in using digital learning games and their cognitive skills. Table 1 summarizes the proficiency in digital learning games, indicating a high mean score (4.21) overall, particularly highlighting students' strong motivation (4.22) and positive attitude (4.36) toward these tools. Despite the lower-rated game interface (4.09), it remains crucial for practical learning experiences. Regarding cognitive skills (Table 2), students showcase high levels of remembering, understanding, and applying (3.73 overall mean), emphasizing foundational skills for critical thinking.

The significant correlation ($r = .636$, $p = .000$) between cognitive skills and engagement with digital learning games indicates the influential role of these games in students' cognitive development. These findings underscore the positive impact of digital learning games on students' motivation, attitude, expectations, and cognitive skills, emphasizing their potential as practical educational tools for enhancing learning experiences and cognitive growth.

These results are consistent with theories like Metacognitive Theory, which highlight students' intentional learning practices and self-awareness (Neelakandan, 2020). Through metacognition, students can evaluate their knowledge, sense of self, and methods for both professional and personal growth. The study also supports the "Deliberate Practice" Theory, emphasizing the deliberate practice that forms the foundation of adaptive learning. This theory backs up the notion that pupils gain from acknowledging their weaknesses and making conscious attempts to get better (Neelakandan, 2020). Overall, the study supports ideas that encourage self-awareness and purposeful learning practices and highlights the beneficial effects of digital learning games on cognitive skills.

Qualitative Phase

Presented in the Thematic map are the themes extracted from the focus group discussion and in-depth interviews with 10 participants concerning the predictor, precisely the influence of digital learning games. Moreover, as shown below, it produced eight themes: Collaboration, Entertainment, Utilization, Limitations, Learner Autonomy, Effectivity, Innovation, and Positive Impact.

Figure 3. Challenges of Senior High School STEM Students in using Digital Learning Games



Collaboration. The participants of this study showed how digital learning games create an engaging and entertaining learning environment which contributes to their learning and their cognitive development.

Participant 2 in IDI shared their experience about Collaboration.

We share..uhm..information and we share and gather information together with our class...for example if our classmates didn't have an answer then we would share ideas or information that we had gathered and then we would discuss it. IDI-Q1.2, P2. (Pg. 126, 590-593)

Liao et al. (2019) found that incorporating instructional videos alongside collaborative learning significantly enhances learning outcomes in the context of digital game-based learning (DGBL). This combination not only supports better achievement but also helps in lowering extraneous cognitive load, which in turn may lead to improved learning.

Additionally, Serrano's (2019) research indicates that digital game-based learning positively influences student engagement. The literature review revealed that incorporating digital game-based learning generally increases student engagement. This conclusion is supported by both quantitative data (pre- and post-tests) and qualitative data (classroom observations and focus group discussions), demonstrating heightened engagement in science classrooms utilizing a digital game-based learning model for instructional design.

Entertainment. The participants of this study revealed how digital learning games create an engaging and entertaining learning environment which contributes to their learning and their cognitive development.

Participant 5 in IDI shared their experience about Entertainment.

Um, I find it engaging because it's like, um, very fun, but at the same time I can also learn. And like, maybe, for this specific, um, subject or topic that I want then that's the only thing that I, like, acquire, and it won't confuse me with other stuff. So, it's like learning is essentially, um, tailored for me, and what my needs are. And like, um, it's challenging for me because I think there are other digital learning tools that require a monthly subscription, or something like that so I might struggle with that because I'm still a student and it's expensive, so, yeah. IDI-Q1.1.1, P1.

Digital Learning Games and Cognitive Skills of Senior High School Students

Adipat (2021) found that game-based learning provides students with an engaging way to explore complex learning environments and concepts, effectively balancing theoretical content with interactive gameplay. This approach can enhance both learning outcomes and student enjoyment. Games encourage students to apply interdisciplinary knowledge and observe how different choices impact results.

Similarly, Nadeem (2023) reported that digital game-based learning significantly increases student engagement and motivation compared to traditional online activities. The use of a leaderboard improved academic performance for some students but could demotivate others. Female students generally enjoyed the games more than males but were less interested in performance comparisons. Overall, the positive student response indicates that incorporating digital game-based learning into instruction can enhance enjoyment and engagement.

Utilization. The participants in this study revealed that using digital learning games enhances their learning and cognitive skills.

Participant 5 in IDI also shared their experience about the utilization.

I think, for me, it's very useful because it seems like its features are tailored to me. And like, it seems like there are many available digital learning tools, um, that are available, like, readily accessible to me. And, so, like it has many features that, maybe this one because I can handpick what it is, like I can use it and fully utilize it, based on what my needs are and depending on academic concepts. IDI-RQ 1.1, P5.

Kougoumtzidou (2023) found that students believe digital games enhance their cognitive skills, particularly in problem-solving and decision-making. Additionally, students reported that these games help develop social skills like collaboration, competitiveness, and empathy. The study indicated that children find digital games beneficial for problem-solving, decision-making, and learning to follow rules, aligning with other research findings. Moreover, digital game-based learning can reduce cognitive load, boost learning performance, and improve motivation, attitude, engagement, and interest in lessons (Chang and Yang, 2023). Gui et al. (2023) also found that digital educational games significantly enhance STEM knowledge and cognitive skills such as problem-solving.

Limitations. The participants in this study revealed that there are limitations to engaging in digital learning games.

For me, I would differentiate it as its limitations and its pros and cons. Okay, first, wait, I'll compare it. If we...If you would...If you were to use digital learning games, it would be very flexible. It's pro, it's very flexible, it's very interactive. It's very autonomous because you can control it as its user. You can gain control of the information you want to learn or the setting you want to use. the way of learning that you want to set compared to the face-to-face because it's limited because you're limited in the way of teaching face-to-face that is student and teacher the teacher teaches the students and the students makes outputs and the outputs are what defines the grades of the students and those or this system is for me is lack..lacks more authenticity because it is very systematic and it is not very effective for most students because they are only passing through higher grades and not pure learning so yeah that's how I differentiate them. IDI-RQ 1.1.3, P8.

Learner Autonomy. The participants in this study revealed that engaging in digital learning games enhances their autonomy level.

Participant 6 in IDI shared their experience about the autonomy.

I think, um I think, um the autonomy level of digital learning is really high in my opinion... since, um, on traditional learning setting, you can't really control when or how you could-, when or how you could congest the knowledge. Unlike digital learning, you can access the game anytime and anywhere whenever you want. So I think the autonomy level is high since you have control, unlike traditional learning setting. IDI-RQ 1.1.3, P6.

Liu et al. (2021) discovered that information feedback in DGBL systems positively impacts learners' autonomous motivation and learning effectiveness by meeting their psychological needs. While game quality directly influences learning effectiveness, it doesn't directly affect autonomous motivation. Autonomous motivation, however, directly affects learning effectiveness. Moreover, learning effectiveness significantly influences the intention to continue using DGBL systems, while autonomous motivation doesn't directly impact this intention. Additionally, Lampropoulos (2023) emphasized the educational benefits of DGBL, including enhancing cognitive and socio-emotional development, improving digital competencies, increasing motivation, engagement, and achievements, and fostering critical thinking, creativity, and imagination in students.

Digital Learning Games and Cognitive Skills of Senior High School Students

Effectivity. The participants in this study revealed that engaging in digital learning games effectively enhances their cognitive skills.

Participant 1 in FGD shared their experience about the effectivity.

The combination of interactivity, simulation, and gamification, etc. makes the digital learning games highly effective for learning STEM concepts. Thus, these features are immersive, engaging, and effective. FGD-RQ2.2.2, P1.

Studies indicate that digital game-based learning can significantly improve students' self-efficacy, learning motivation, and achievements, resulting in better learning outcomes compared to traditional methods (Chen and Tu, 2021). Additionally, according to Yang et al. (2023), digital educational games hold promise for enhancing STEM learning by creating engaging virtual environments that facilitate interaction with game mechanics, thereby promoting STEM literacy, problem-solving, and critical thinking. Wang et al. (2022) suggest that digital games have the potential to positively impact students' learning outcomes and attitudes in STEM education through cognitive development, immersive learning experiences, and achieving diverse learning goals.

Innovation. The participants in this study revealed that engaging in digital learning games innovates their learning skills.

Participant 8 in IDI shared their experience about the innovation.

In this current generation, there are more modalities present like the online, the blended, the module, the face-to-face, and incorporating digital learning games towards those modalities are like introducing a new modality that is the digital learning games, I think that it is very kind of innovative in a way that it can be more kind of relevant to this current society, because many of us youth is fond of playing games and if we incorporate our learn... if we incorporate our studies with those games, feel like...that we can learn and enhance our knowledge and enhance our information gathering skills. IDI-RQ 1.1.2, P8.

Digital educational games are lauded for their ability to enhance student motivation and create an engaging learning environment, preferred by both educators and students (Li et al., 2024). Moreover, compared to traditional methods, implementing digital game-based learning can boost students' self-efficacy, motivation, and achievements (Chen and Tu, 2021).

Positive Impact. The participants in this study revealed that engaging in digital learning games positively impacts and enhances their cognitive skills.

Participant 3 in FGD shared their experience about the Positive Impact.

Same with what I've mentioned earlier which is positive. I would say that there's a positive impact with engaging with digital learning games in developing my cognitive development. FGD-RQ 2.1.1 P3.

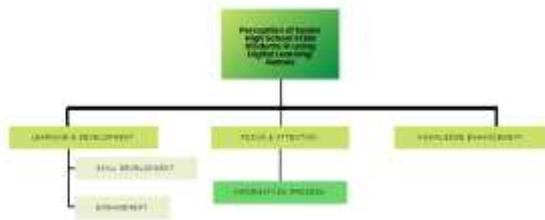
Digital games often feature complex challenges and puzzles, prompting players to analyze situations, strategize, and make informed decisions. Engaging with these problem-solving demands can lead to enhanced real-world problem-solving skills (Skitii, 2023). Moreover, digital games are recognized for their potential to positively influence students' learning outcomes and attitudes. They promote cognitive development, offer immersive and enjoyable learning experiences, and cater to diverse learning objectives (Khuda et al., 2022).

Extensive. The participants in this study revealed that engaging extensively in digital learning games enhances their cognitive skills.

Participant 3 in IDI shared their experience about the Extensive.

Uhh, what are my opinions... my opinions regarding its adaptability in accommodating diverse learning preferences and abilities is that, it can cover other lessons or topics but there are other lessons that are too hard to cover that even digital learning games can't do. IDI-RQ 1.1.2, P3.

Figure 4. Perception of Senior High School STEM Students in using Digital Learning Games



Learning and Development. The participants in this study revealed that engaging in digital learning games enhances their learning and development.

Participant 8 in IDI shared their experience about the Learning and Development.

Digital learning games are still games, it can be called as a game. And games require problem solving skills and critical thinking skills. And for me as a student, that can really help enhance my problem solving skills, developing my problem solving skills can really enhance my critical thinking skills. Because now we have more new and modern technologies, so it needs to be more innovative in order to make it more adaptive or more adaptable in terms of change. As a student, we need to see more enhancements and innovations in the future. I think these digital learning games are one of it. So if you start and utilize this modality, it's easier for you to adapt to the future technologies. It's easier for you to enhance your skills as a student, like your problem solving skills, your thinking skills, your...other cognitive skills. IDI-RQ 2.2.1, P8.

Integration of DGBL in educational settings has shown to boost self-efficacy, learning motivation, and achievements, underscoring its role in enhancing learning outcomes and cognitive skills (Wang et al., 2022). Moreover, the use of digital games like Prodigy Math has proven successful in providing an engaging and standards-aligned platform that supports adaptive learning and differentiation, ultimately improving learning experiences and outcomes for students (Chang and Yang, 2023).

Focus and Attention. The participants in this study revealed that engaging in digital learning games enhances focus and attention.

Participant 8 in IDI shared their experience about the Focus and Attention.

For me, digital learning games can be very destructive in your learning journey. It may be. It can uh enhance your cognitive skills and your and your learning but it's a game and games can be entertaining rather than, it can be more entertaining rather than being more informative and in that way students are more focused on entertainment than on information and that is kind of they have conflicts. Their relationships are very kana jud intertwined. If you are a player, you can use or manage your digital learning. If you are a player, you can utilize your digital learning games. It will be more effective to enhance your cognitive skills throughout your academic journey. IDI-RQ 2.1, P8.

Recent research demonstrates the positive impact of Digital Game-Based Learning (DGBL) on learners' focus and attention. Chen and Tu (2021) found that digital games enhance cognitive skills, including attention, by requiring players to process visual and auditory information simultaneously. The interactive and immersive nature of DGBL sustains learners' focus and engagement throughout the learning process. Additionally, the adaptive nature of platforms like Prodigy Math adjusts difficulty levels based on individual performance, aiding in maintaining focus and engagement. Well-designed digital learning games maintain learners in a state of flow by offering challenges aligned with their skill level, thereby sustaining focus and motivation. Immediate feedback and rewards further reinforce learning and keep learners attentive (Nisbet, 2023). Noted by Chan and Yang (2023) presenting information interactively, DGBL helps learners focus on relevant content, reducing cognitive overload and enhancing learning outcomes.

Knowledge Enhancement. The participants in this study revealed that engaging in digital learning games enhances knowledge and cognitive skills.

Participant 9 in IDI shared their experience about the Knowledge Enhancement.

Digital Learning Games and Cognitive Skills of Senior High School Students

For me, digital learning games can really help, especially since I have short-term memory loss [laugh]. I don't know, but if I enjoy what I'm doing, I don't forget it. It's like it keeps coming back to my mind. So, for example, if I need to memorize something, it's easier for me because I enjoy the method of memorizing using digital learning games. IDI- RQ2.1, P9.

Trique and Khan's study (2022) found that while there was no significant difference in pre-test scores between control and experimental groups, both showed notable improvement in post-test scores, with the experimental group, taught through DGBL, exhibiting greater progress. Importantly, the comparison of post-test scores indicated a significant advantage for the experimental group, suggesting that DGBL effectively enhanced academic performance, particularly in mathematics, underscoring the importance of a strong theoretical framework for the successful integration of DGBL in educational settings.

Implications and Recommendations

Based on the findings of the study, the following conclusions are presented:

The digital learning game efficiency is apparent in improving the cognitive skills of the students. This implies that students exhibit a significant capability and competency in using digital learning games as a tool for improving learning experiences. Hence, the usage of digital learning games may be applied to further enhance their skills.

Furthermore, the senior high school STEM students performed exceptionally well in terms of their cognitive skills. This shows that learners exhibit advanced cognitive abilities, such as critical thinking, problem-solving, and effective memory retention upon improving and fostering their academic pursuits. This emphasis underscores the potential positive impact on students' proficiency across diverse subjects and cognitive challenges.

The relationship between the two variables was significant, indicating that digital learning games do have a strong influence on the development of the students' cognitive skills. In this regard, it highlights the effectiveness of digital learning games as an educational tool for senior high school STEM students, making it a pivotal instrument for cognitive skill enhancement.

The Department of Education is encouraged to incorporate digital learning games as a strategy to increase learners' cognitive skills. This approach should be designed to accommodate diverse cognitive levels, all while aligning with the current curriculum to strengthen and solidify students' grasp of the subject matter. Given the widespread access to technology among students today, leveraging digital learning games can make the educational experience interactive, promote deeper understanding, and enhance engagement. This utilization of technology not only enriches students' knowledge but also contributes to the improvement of their cognitive abilities.

Administrators and school heads could implement this approach into the curriculum, especially as the institution transitions towards becoming a smart school. This move is vital to ensuring that the time spent on digital learning games contributes effectively to the achievement of overall learning goals for the students. To implement this successfully, administrators can offer a diverse array of digital learning games covering various subjects and skills, catering to the different learning styles and interests of senior high school students. Moreover, administrators may facilitate training and professional development opportunities for teachers; this training would help educators become more familiar with how to effectively incorporate digital learning games into their teaching methods, optimizing the use of these tools for educational outcomes. The school heads enable them to support students' learning development and success while concurrently enhancing their cognitive skills.

Teachers may incorporate digital learning games into the curriculum, aligning them with specific topics covered in their instruction. By doing so, teachers can effectively monitor students' progress and identify areas of difficulty for the majority of students. This information enables teachers to provide targeted support and assistance, facilitating a better understanding of complex concepts. Additionally, teachers can gauge the effectiveness of digital learning games through feedback from students and observable learning outcomes. This feedback loop allows teachers to make necessary adjustments to enhance the comfort and effectiveness of students' learning experiences. Importantly, digital learning games should be seen as complementary to traditional teaching methods, seamlessly integrated into teachers' overall instructional practices. Teachers can strategically include these games in their lesson plans, using them as supplementary tools to enrich classroom instruction.

It is recommended that students acquire proficiency in the effective and efficient utilization of digital learning games. Understanding their strengths and weaknesses concerning these tools is pivotal. This self-assessment not only enhances their learning process but also holds potential benefits for their cognitive skill development. Thus, it is advised for students

to assess their capabilities in using digital learning games, which could significantly contribute to their academic progress and cognitive abilities.

Game developers are recommended to possess a comprehensive understanding of the impact of digital learning games on students. Their focus should be on crafting these tools to be both engaging and educational. While striving for the creation of enjoyable and stimulating games, developers must remain steadfast in prioritizing the primary goal: facilitating learning through these digital platforms. Moreover, developers should dedicate efforts towards enhancing features that are deficient by identifying strengths and weaknesses. An integral aspect involves a profound understanding of the target audience, delving deeper into their preferences and needs. Therefore, it is imperative for game developers to not only create engaging games but also to continuously improve and tailor these tools to effectively support the educational journey of their intended audience.

Lastly, for future researchers, it is advised to extend research efforts beyond cognitive skills to encompass additional domains such as affective and psychomotor skills. Also, expanding the scope of this research to include a more diverse and extensive range of respondents is strongly recommended. Furthermore, it is suggested that future research explores the longitudinal effects of prolonged exposure to digital learning games on cognitive development. This will provide a more detailed perspective on their influence on cognitive abilities over time. New findings should be shared as they could potentially establish the groundwork for upcoming research endeavors.

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