

MATHEXpress: A Product Development Study of Addition Game Board for Kinder to Grade 1 Learners

Alma M. Flores¹, Renashel E. Condrillon², Rhea Cassandra V. Tisoy³,
Fanny Mae Mobida⁴

^{1,2,3,4}Cebu Normal University

Abstract:

This study examines the perspective of experts on the newly developed product addition game board, this study aims to improve the addition skills of learners in kindergarten to grade one in mathematics. It seeks to identify possible improvements in the product. This study utilized a descriptive-qualitative design to gather relevant information from the experts using semi-structured interviews. The respondents of this study are fifteen purposely selected Engineers, Special Education, and General Education Teachers in Cebu. The researchers employed purposive sampling in selecting the respondents. Thematic analysis was used in analyzing the data gathered that resulted in five themes. The result shows that the product can potentially stimulate engagement in teaching number recognition and basic addition skills to kindergarten to grade 1 learners, including those with special needs. However, it may not be suitable for lower-level learners with intellectual disability. Experts' recommendations of this study include: enhancing safety measures, prioritizing cost-effectiveness in material selection, and improving the product's appeal and effectiveness in educational settings through various enhancements like incorporating basic subtraction, adding interactive elements, considering ergonomic design features, correct use of colors and sounds to prevent sensorial discomfort. To expand the product's educational value, the researchers suggest to conduct an in-depth evaluation on its feasibility and effectiveness in actual classroom settings.

Keywords: Game Board, Addition, Young Learners, Product Development, Mathematics

1.0 Introduction

Mathematics is a field of study that deals with numbers, quantities, shapes, and patterns that encourage logical and critical thinking among students. Most students dread this subject, as teachers witness in their classrooms the unfortunate reality that it is often perceived as one of the most challenging subjects for a majority of students (Langoban, 2020). Around 15–20% of students in a classroom of twenty students struggle with mathematics including severe cases such as developmental dyscalculia (5-7%) and poor math performance (10–15%) (Mononen, 2019).

There are various reasons as to why some children have difficulty in math. One common reason is dyscalculia. Dyscalculia is a specific learning disability that hampers an individual's ability to perform and understand mathematical concepts and may have struggles in recognizing, remembering, and counting numbers, understanding basic patterns, and performing basic mathematical operations (The Understood

Team, 2023). Moreover, children with neurodivergent problems such as ADHD, autism, dysgraphia, and dyspraxia may also struggle with math (Stanley, 2021). Additionally, according to Zilaey et al. (2017), students with intellectual disability also have difficulties in learning mathematical concepts, with attention as one of the identified critical factors since intellectual disability is often associated with attention problems.

However, it is important to note that not all math difficulties are caused by the aforementioned disabilities. Other factors such as the lack of building blocks, math anxiety, and inadequate parental support to their parents also contribute to low math performance in children (Nisbet, 2019; Kisner et al., 2009). In children aged 5-7 years, environmental factors including linguistic variations, exposure to math-focused language, socioeconomic position, attitudes and views about math, and participation in math activities significantly impact young children's math performance (Silver and Libertus, 2022). Difficulty in learning math is prevalent among children. Hence, as early as possible, these difficulties should be identified to develop teaching strategies and provide appropriate support, such as additional practice, better instruction, or specific interventions for identified learning disabilities, to help children overcome these difficulties.

In the Philippines, children perform worse than the international average in cross-cultural studies on student mathematical success, such as the Trends in International Mathematics and Science Study (TIMSS) 2003 and TIMSS Advanced 2008 (Mullis et al., 2004, Mullis et al., 2009; Cheung et al., 2020). According to the results of the 2022 Programme for International Student Assessment (PISA), the Philippines placed bottom out of 81 countries. The Philippines scored sixth from the bottom in mathematics with an average score of 355 (Montemayor, 2023). Therefore, the Philippines commonly performs poorly on the international average, particularly in mathematics.

Making mathematics easy and engaging for children is one of the most challenging tasks that teachers face (Langoban, 2020). Polo-Blanco and Lopez (2021), further stated that recent attention has been directed toward assessing the math performance of students who are facing difficulties in learning this subject, to formulate teaching strategies and interventions tailored to their requirements. One example of this is gamification in learning. The use of Gamification in learning has emerged as an effective approach for addressing the difficulties associated with teaching mathematics to young learners. In the upcoming years, gamification may be used in educational settings for students.

Gamification is regarded to be effective in focusing students' interests toward educational pursuits, and this can create an environment where students are more likely to succeed as individuals in both their social and academic lives (Lee & Hammer, 2011; Karamert & Vardar, 2021). Gamifying lessons in mathematics can be quite beneficial, particularly in the Philippine context. Research has demonstrated that incorporating games into math instruction can improve students' mathematical ability, motivation, and overall learning results.

Recognizing the need for improvement and to address the identified gaps, a thorough investigation becomes essential. This study aims to improve the mathematical skills of young learners, both typical and atypical, by developing a game board that further aims to engage Kindergarten to Grade 1 learners specifically in addition by using the product development process. The findings of this study will lay the groundwork for a recommended action plan.

2.0 Methodology

2.1 Research Design

This study employs a descriptive-qualitative design with a focus on developing a game board to be used

in teaching mathematics specifically in addition to enhancing young learners ranging from Kindergarten to Grade 1 levels' learning and engagement in math. Rather than exploring an event's underlying mechanisms or causes, descriptive qualitative research focuses on analyzing its characteristics. Descriptive qualitative research aims to provide a thorough and accurate description of the phenomenon under inquiry. This method's perceptive investigation helps to shape policy or practice and facilitates the creation of new research questions (Regoniel, 2024).

2.2 Sampling Design, Research Respondents, and Environment

The target respondents of this study will be Special Education (SPED) and Early Childhood Education (ECE) teachers and engineers from selected schools in Cebu. The researchers will interview five (5) Special Education teachers, (5) Early Childhood Education teachers, and five (5) engineers with 15 total respondents. According to the Nielsen Norman Group in 2021, in an interview-based study, the sample size should range from as little as 5 to 50. In selecting the respondents, convenience and purposive sampling will be employed. Convenience sampling, also known as "haphazard" sampling or Coincidence Sampling, is a probability nonrandom sampling technique whereby participants are selected from the target group based on their fulfillment of particular functional requirements, such as physical proximity, ease of access, accessibility at a particular time, or consideration of their participation for further investigation. It also refers to the research population's subjects who are easily accessible to the researchers (Etikan et al., 2016). Purposive sampling is a collection of various non-probability sampling methods. Purposive sampling, sometimes called judgmental, selective, or subjective sampling, depends on the researcher's judgment in choosing the units (individuals, cases/organizations, events, or data points) that will be examined (Rai & Thapa, 2015).

2.3 Research Instrument

The researcher is the main instrument in qualitative study. According to Hammersley & Atkinson, 1995; Pezalla, 2012, "The term "researcher-as-instrument" refers to the researcher's role as an active participant in the research process." A semi-structured interview will be employed. This is a type of data collection instrument in which questions are asked within a predetermined theme framework. The questions, however, are not in any particular order or phrasing. Semi-structured interviews are frequently qualitative in research. Marketing, social science, survey techniques, and other research domains are commonly employed as experimental tools (George, 2023).

Research Process

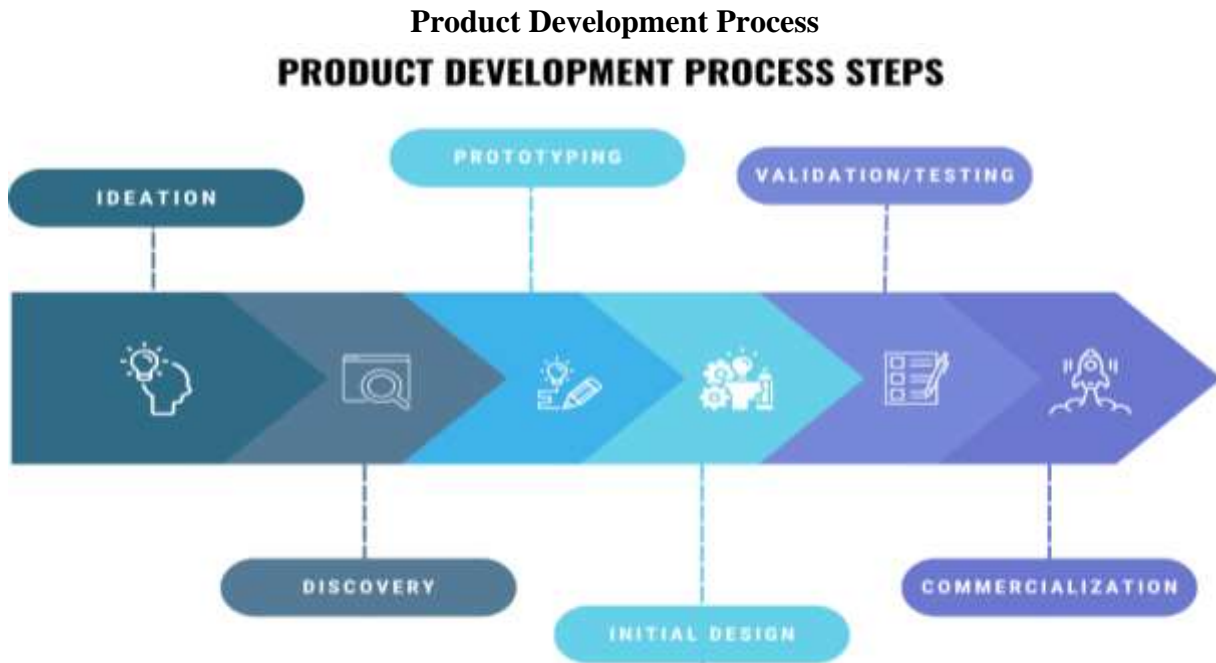


Figure 1. Product Development Process. Adapted from <https://asana.com/resources/product-development-process>

Ideation

Name of the product: MATHEXpress

MATHEXpress stands for Mathematical Addition Train for Hands-on Experiential Learning & Expressive Summation

Discovery

This utility model represents an inventive fusion of education and entertainment, redefining the gaming landscape by drawing inspiration from the traditional chessboard concept and evolving into the innovative Addition Game Board.

This game board has a specific focus on aiding students in grasping additional concepts through an interactive and entertaining game. According to Noda et al. (2019), board games benefit education, cognition, physical activity, anxiety, ADHD symptoms, and Alzheimer's Disease severity while also improving interpersonal interactions, motivation, and learning as an effective complementary therapy.

The incorporation of a die adds an exciting element to the gaming dynamics, introducing an element of chance and unpredictability, serving as a captivating indicator for determining the addends in the game. Players now navigate their numbers through the roll of the dice, enhancing the overall excitement and engagement of the gaming experience. According to the research of Pennant in 2018, by allowing the learners to interact with the dice physically, dice games give learners hands-on learning opportunities that support their understanding of math concepts such as addition and subtraction. This promotes their literacy in mathematics and also their comprehension. This integration makes the Addition Game Board a versatile and dynamic platform for learning and fun.

This product was inspired by a teaching tool and turned into a game board called the "MATHEXpress." This is designed to make additional learning experiences simple, accessible, engaging, and enjoyable.

Prototyping

Views of the Drawing

Figure 2. Section 1 (Upper half of the box)

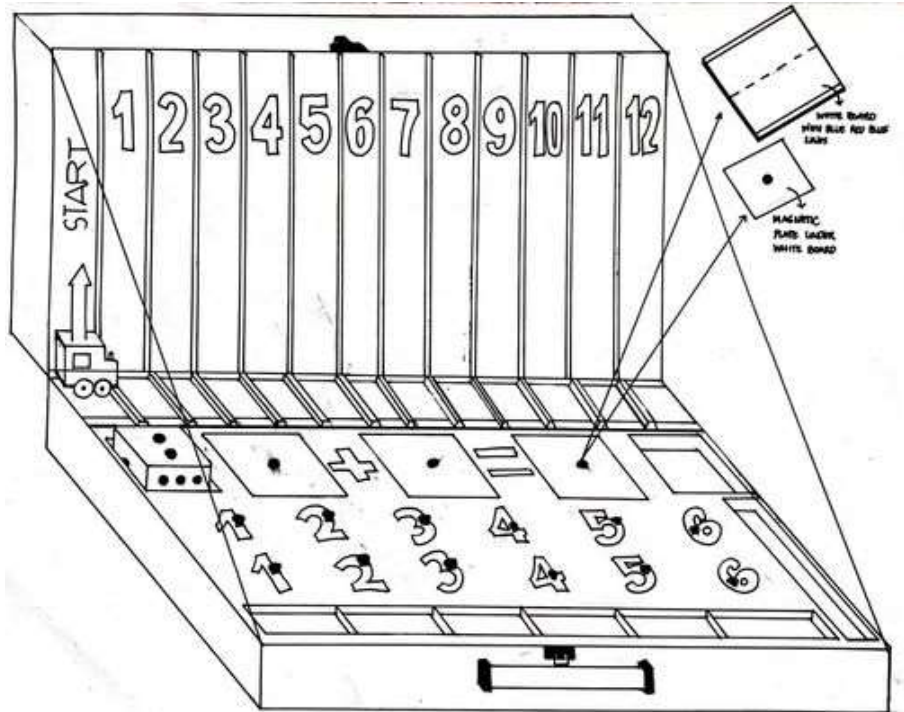
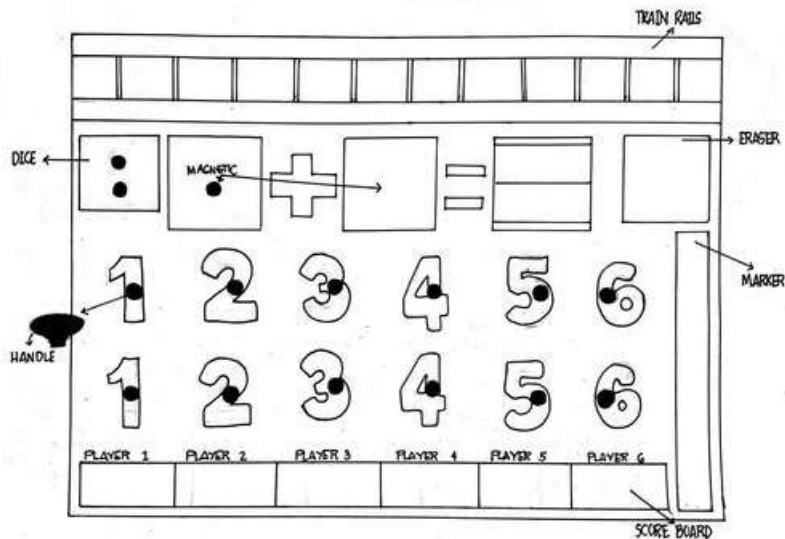


Figure 3. Section 2 (Lower Half of the box & Top view of Section 2)



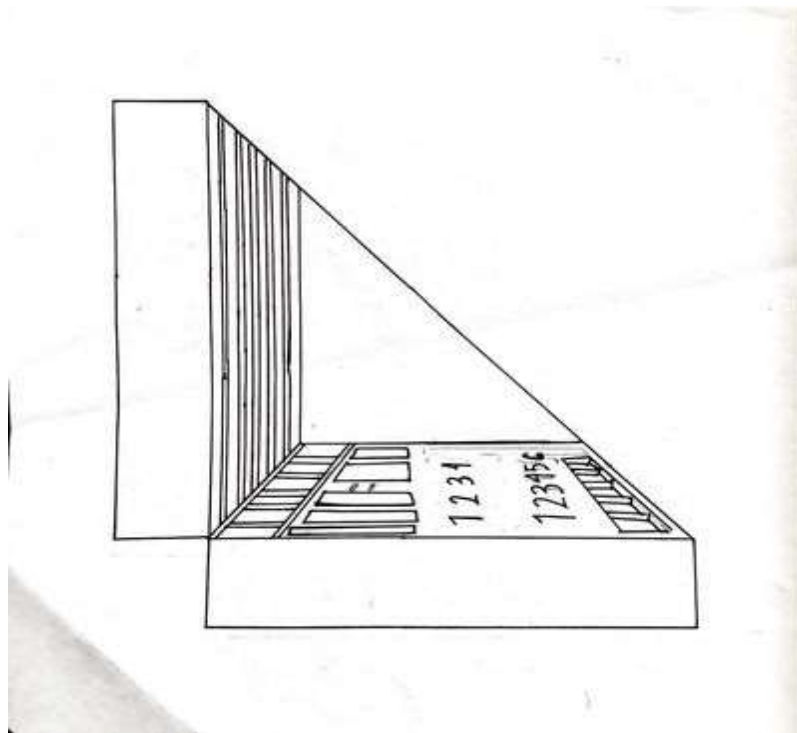


Figure 4. Side View

Initial Design



Figure 5. Front view of product's initial design



Figure 6. Side view of product's initial design



Figure 7. Image of product's initial design when closed

Detailed Design Description

An innovative gaming product that effectively integrates education and entertainment. This board unfolds into two parts, with each having different purposes.

Section 1:

When the first section is opened, numbers 1 through 12, and lights in different colors are displayed on top of the board, dividers are placed between the numbers, connected to the rails, and serve as stoppers for the train. These dividers indicate the values to be added based on the result of the dice. This part serves as the foundation for analyzing mathematics. In addition, the numbers 1-12 are connected to the train rails in Section 2.

According to Ozcan et al. (2022), the integration of embedded electronics and hidden sensors in toys

enhances interactive behaviors through features like colorful lights and gentle vibrations, captivating children's attention.

Section 2:

In the second section, the board has a string that can help the board stand independently to a 90-degree. A train and rail using wood divider stoppers are provided to help the students visualize mathematical equations and make the game board exciting. A button can be found beneath the train rails connecting to the lights behind the numbers 1-12 above. In order to light up the numbers, the train wheels push the button beneath the rails as it passes through it, making the game immersive, and adding emotional experiences for the learners.

Physical toys, such as number pegs and train toys, engage children in enjoyable learning experiences while monitoring fine motor skills, aiding educators and parents in tracking skill development progress (Mironcika et al., 2018).

Two magnetic addend carve boxes are located beneath the rail, for players to create their equations, and a magnetic and detachable whiteboard where the student can write the sum of the addends and raise their answers. Syahputri et al. (2020) suggest that whiteboards can promote creativity in note-taking and enhance imagination. Incorporating whiteboards into classroom activities also fosters teamwork and communication skills (Michelle, 2023).

The equation crafting is finished with a whiteboard, an equal sign, and an addition sign. Arabic numbers from 1-6 are provided. The die indicates what number block is placed on the addends slot. According to Syahputri et al. (2020), whiteboard is a traditional and widely-used classroom teaching aid, it revolutionized education for two centuries, promoting creativity in note-taking and enhancing imagination.

A six-player scoreboard with five stars on each one is used to track progress. For all players, the game promotes tactile and visual learning, making it an inclusive and stimulating experience.

Validation/Testing

The product has been certified by Engr. Welven B. Agua, a Research Adviser and Consultant in Cebu Technological University (CTU) Argao Campus together with Jacqueline K. So, graduated with a bachelor's degree in civil engineering and Allen M. Flores graduated with a degree in industrial technology in Cebu Technological University (CTU) Main Campus. Their professional backgrounds and education equip them with the knowledge and skills necessary to assess the quality, functionality, and practicality of the product. Their certification confirms the product's adherence to standards of excellence and its suitability for addressing real-world challenges in engineering and technology domains.

Commercialization

Market

The Addition Game Board targets the educational gaming market which connects both the game board and educational sectors. This target demographic is experiencing growth as parents and educators are constantly seeking engaging educational tools that blend entertainment with learning outcomes. The product aligns with the trend of integrating technology and interactive features into educational toys, as highlighted by research by Ozcan et al. (2022).

Target Market

The target market of this product, if it is developed further, will be educators particularly in early childhood

education and special education (SpEd), parents, and caregivers who are seeking innovative and interactive educational tool that allow children aged 5-7 years old to have fun while being in the process of learning. Educational institutions, including schools and learning centers that are looking for hands-on resources to enhance mathematical learning experiences are also included in this product's target market. This Addition Game Board is most beneficial to children who are interested in hands-on activities and are visual learners. Added features like colorful lights and buzzing sounds, tactile components, and a colorful theme design, aims to capture children's attention and encourage excitement to learn mathematical concepts.

2.4 Data Gathering Procedure

The first part of the gathering procedure was the approval from the Research Ethics Committee. After the clearance was released, formal permission was sought from the chosen participants of the selected school in Cebu. The purpose was to conduct interviews with fifteen (15) teachers, five (5) from early childhood, five (5) from special education, and five (5) engineers using semi-structured questionnaires as the guiding tool. Teachers were informed that participation was voluntary, and consent had to be obtained before any participation.

The teachers and engineers were interviewed in five parts. In the first part, the researchers introduced the product to the teacher along with the game's manual, mechanics, and criteria. The second part was the interview wherein the researchers gathered the demographic information of the teachers. The third part was the introduction of the interviewers and setting the expectations between the interviewees. The fourth part is the presentation of the actual interview questions. Lastly, when the entire or the majority of the selected teachers completed answering the questions, the researchers gave the participants a token of appreciation and a certificate signed by the researchers and adviser.

2.5 Data Analysis

Thematic Analysis was employed to analyze the data collected from the results of the interview. The thematic analysis involves a structured process of grouping information into different codes, arranging these codes into themes, and then identifying patterns and connections between these themes. This method will help thoroughly understand people's experiences, thoughts, and viewpoints on a particular topic (Jowsey et al., 2021).

2.6 Ethical Considerations

Protecting participants' rights and well-being is crucial to any research. Issues on confidentiality and anonymity were considered, requiring the participants not to write or state their names; instead, they were given codes. Data was securely saved for the researcher's access only. Participants may withdraw from the study without penalty. The study also followed ethical guidelines set by relevant institutions or governing organizations to ensure ethical and responsible research techniques and activities. An ethics committee examined and approved the research protocol to ensure ethical compliance and participant safety. An Informed Consent Form was completed before the in-depth interview, emphasizing the sought permission to record the conversation. Lastly, as a token of appreciation for the valuable participation in this research study, all participants received a certificate signed by the researcher and instructor and a thoughtful gift upon completion.

3.0 Results and Discussion

Following the thematic analysis of the methodologies and findings of the study, five (5) emergent themes were discovered: engagement stimulation, durability and strengths of the product components, safety and suitability, cost effectiveness, and product enhancement suggestion and recommendations.

Theme 1: Engagement Stimulation

The result showed that the addition board game stimulates engagement in learning activities, particularly among young learners. The experts indicated that the product captures the interest of the learners, facilitates comprehension, and encourages active participation. These were supported by the responses of experts that:

Gen-Ed Teacher 1: "It captivates learner's interest, facilitates understanding, and encourages active participation."

Gen-Ed Teacher 2: "Useful and appropriate for the target learners. Excellent way to make learning fun. Very creative and unique. It makes the learning fun and enjoyable."

Gen-Ed Teacher 3: "Maka-engganyo sa bata ug ihap-ihap ug add-add."
English Translation: "It entices the child to look closely and do addition."

Gen-Ed Teacher 4: "Relevant since pwede ug number recognition among kindergarten to grade 1 learners"
English Translation: "Relevant since it can aid in number recognition among kindergarten to grade 1 learners."

SpEd Teacher 1: "The product is useful and interactive...innovative since the material helps the learning of the child to engage in numbers."

SpEd Teacher 2: "The lights and sound are interactive to the learning of the child. Yes, it can catch the attention of the child and it will motivate the child in answering the addition."

The responses from the experts reveal that the product is useful, relevant, and interactive, particularly for teaching number recognition and addition from kindergarten to grade 1 learners. The experts emphasize the effectiveness of the product in engaging young learners in the learning process. According to Samuel (2023), Board games stimulate engagement, foster social interaction, and contribute to cognitive development and personal growth by promoting strategic thinking, problem-solving, and decision-making. The responses from the experts highlight the effectiveness of addition train board in stimulating engagement and facilitating learning among learners, particularly in areas such as number recognition and basic addition. This implies that the board game foster engagement, improves the learning experiences and fosters cognitive development among young learners.

Theme 2: Durability and Strengths of the Product Components

The gathered responses of the experts revealed that the game board possesses several positive elements that make it innovative and functional as an instructional material. These elements include the board's

durable construction and the appropriateness of some of its components for its intended audience, contributing to user-friendliness and enhancing the tactile experience for users. These were supported by the responses of experts that:

Sped Teacher 4: "It's heavy, but also durable, dili jud siya ma unsa-unsag guba so if you're going to place it somewhere sa kilid sa room, dili jud siya maguba... if you're going to place it in a table or stand, mas better if ning ana siya ka bug-at kay dili jud siya maguba (referring to the product as a whole)."

English Translation: It's heavy, yet durable at the same time, it's not easily broken so if you're going to place it somewhere in the room, it will not be broken...if you're going to place it in a table or stand, a heavier weight like this is better as it reduces the risk of damage.

"It's good na ing ana siya ka heavy because ang mga studyante para Dili nila ma bira-bira especially ID students (referring to the product as a whole)..."

English Translation: It's good that it's heavy because the students cannot easily pull it especially ID (Intellectual Disability) students.

Engineer 4: "...well-crafted, and offers a distinctive learning approach."

Engineer 3: "In a scale of 1-10 I'll give 9 to its durability."

These statements imply that the game board is durable. It is important for instructional materials to be durable for them to be safe and usable over time, providing a safe and reliable learning environment for students, educators, and staff (Arsenault, 2023). One of the factors that teachers consider in utilizing instructional materials is the durability and safety to ensure that they can withstand regular classroom use without posing any hazards to students or educators. In special education classrooms, learners may have sensory sensitivities or motor challenges, which is why experts, particularly the special education teacher, commended the game board's durability, ensuring that it does not break easily when used by learners. This implies that the game board is durable and that the more durable the instructional materials are, the safer they are to use.

Aside from the game board's durability, the results also showed that although not all, but some of its components, such as the dice, number pegs, and detachable whiteboard, are easy to manipulate and appropriate for its intended audience and purpose. The experts emphasized that the edges of the objects present on the game board should not be sharp to ensure learner's safety. These were supported by the responses of experts that:

Gen-Ed Teacher 1: "The wood board is handy."

Gen-Ed Teacher 4: "Nindot siya (referring to the dice) kay dili sharp ang edges unya dako sad siya aron dili makaon sa bata."

English Translation: This is nice (referring to the dice), as its edges are not sharp, and the size is big enough to prevent children from swallowing it.

Sped Teacher 1: "Easy to grasp for the child (referring to the dice)."

Engineer 2: "good, can't be swallowed, as long as no sharp edges (referring to the dice)."

Sped Teacher 2: "The number pegs are convenient to use for the child, since it is magnetic/ it has magnet." "The white board's size is appropriate for the material."

Gen-Ed Teacher 3: "Para nako sakto ra ang gidak-on sa number kay klaro kaayo siya."

English Translation: For me the size of the number [pegs] are appropriate as it's very clear.

Sped Teacher 2: "The product is easy to manipulate ..."

Engineer 4: "...highly user-friendly..."

This means that the aforementioned game materials are easy to manipulate and appropriate for children's use as components of the game board, making it more user friendly. Tangible materials, such as manipulative objects, are particularly beneficial for slow learners and those with learning difficulties (Ojating, 2022). In selecting game materials they should be appropriate and safe to ensure that children are protected from potential hazards such as choking, sharp edges, toxic chemicals, and other dangers that could harm their well-being (Ianelli, 2021). Choosing suitable game materials can help not just teachers but also parents to create engaging and educational play experiences that align with children's developmental needs and interests that can contribute to their overall well-being and growth (Toys and Games for Children, 2023). This not only fosters their overall well-being but also promotes their growth and learning. Therefore, careful selection of game materials is important in creating games that provide enriching experiences for children while prioritizing their safety and development.

Theme 3: Safety and Suitability

Based on the responses gathered from the participants, the results showed the recommendations of the experts that would improve the suitability and safety of the addition game board when used by both learners and teachers. The experts suggested that it is important to consider various aspects of the product to ensure safety among the users. These were supported by the responses of experts that:

Gen-Ed Teacher 1 and 3, Engineer 2: "Needs edge smoothing and a stopper to prevent accidental closure."

Gen-Ed Teacher 1 and 3: "...guide lang nimo ang mga bata inig duwa nila kay naa gyuy posibilidad nga mag duwa2, maigo sila."

English Translation: "...make sure to supervise or guide the children when they play because there is a possibility that they might play roughly and hurt themselves."

Gen-Ed Teacher 4 and Engineer 2: "Bug-at siya, mag lihok-lihok niya madat-ugan ta, so better na e lighter ang board."

English Translation: "It's heavy, and if it moves around, we might get hit, so it's better if the board is lighter."

Sped Teacher 4: “Ang akong pangunahing problema ay, is it's very heavy, kuyaw ta malabay [sa mga bata]...”
English Translation: “My main concern is that it's very heavy, it's risky if it's thrown [by the children]...”

Engineer 1 and 3: “...it may lead to a potential electrical hazard (referring to the wiring installation).”

Engineer 4: “...when the board is closed, the nail heads are visible, posing a risk of scratching for users. I recommend using wood filler to prevent this issue.

Engineer 4: “Wooden dice are generally considered to be reasonably sturdy, although their durability can depend on factors like the quality of treatment and storage conditions. Taking proper care, such as handling them gently during use and storing them in a dry environment, can contribute to preserving their durability over time. “

The experts point out the significance of considering product safety and carefully evaluating the addition game board's many features, including its weight, size, edges, supervision, and guidance. Experts suggest that students should be warned, and expectations should be set before they handle sharp objects, such as woodworking tools, in educational settings. The students should also be given proper guidance and supervision. It's essential to regularly inspect educational materials, including game boards, to locate possible wear and tear from the product. This is especially important for plastic and wooden materials, as they can deteriorate over time and pose safety hazards to whoever is handling them (The Department of Defense Child Development Virtual Laboratory School, 2023). The experts suggest polishing the product's edges and putting a stopper on the board so that the users would not be holding it throughout the game and also as workable safety measures to reduce the risk of injuries from the product closing by itself. Additionally, based on these statements from the experts, there is an issue concerning the product's weight as it indicates a potential hazard to the users. Handling heavy objects can present certain risks, especially on school premises, where unintentional drops are more likely to happen. Apart from that, another expert expressed concern about the possibility of an electrical hazard resulting from installing the wiring. Another expert also saw a possible safety issue regarding the board's design. They point out that users can risk getting scratches when the board is closed because the nail heads are visible, and some are protruded. The experts suggest using wood filler to cover up the nail heads and reduce the chance of injury.

In addition to prioritizing the users' safety, evaluating how well the product satisfies or suits the needs of the target market is also significant. Mittal (2023) highlights how creating compelling product descriptions requires a thorough understanding of the target market. Ensuring the product is suitable for the intended audience is just as important as tailoring descriptions to the tastes and passions of the intended audience. As a result, determining the product's suitability for the intended learners entails not only ensuring safety but also addressing their specific needs and preferences. These were supported by the responses of experts that:

Engineer 1: “Metal dice are more durable than plastic dice, but plastics material dice is recommended for the students (to be used).”

Engineer 1: “All shapes are appropriate. In sizes atleast 2 inch in diameter or above.”

These statements shed light on material suitability for children. In addition to considering your child's interests and asking him what he wants, one of the most important factors to consider is the toy's age recommendations. For younger children, it will assist you in avoiding toys with small parts and those that pose choking hazards (Iannelli, 2021). Choking on small parts is a leading, but preventable, cause of injury and death in infants and young children (Neofotistos et al., 2017). Specifically, you should avoid toys with small parts that can fit inside a choke test cylinder or no-choke testing tube, which is 1 1/4 inches wide by 2 1/4 inches long and simulates the size and shape of a young child's throat (Iannelli, 2021). Engineer 1 suggests that, while metal dice may be more durable, students should use plastic dice, indicating a preference for materials perceived to be safer for children. It also means that safety inspections are given a focus when choosing materials that align with the requirement to ensure that products are suitable for the people they are intended for. In addition, Engineer 1 notes that objects or items with a diameter of two inches or more are suitable for usage especially for younger users as it keeps them from choking or swallowing hazards. These components show a dynamic approach to choosing kid-safe and long-lasting materials, indicating a commitment to the well-being of young learners in the learning setting.

Theme 4: Cost Effectiveness

The cost-effectiveness of the product must be taken into consideration according to the opinions of the experts. The experts expressed concerns about the initial expenses and durability of the product, and they recommended the convenience of having a rechargeable battery for potential long-term savings. The expert's opinions were supported by the following responses:

SpEd Teacher 3: "...mas convenient if rechargeable ang battery, aron mas maka save ka (referring to lights and sounds)..."

Translation: "...it's more convenient if the battery is rechargeable, so you can save more (referring to lights and sounds)..."

SpEd Teacher 4: "... mahal siya because of the technicalities and its durability..."

Translation: "...it's expensive because of the technical features and its durability..."

The experts highlight how important to consider the cost-effectiveness of the product, especially in terms of long-term savings and durability. The experts also assess the potential benefits of rechargeable batteries and evaluate the initial funds and long-term value of the product. Cost-effectiveness analysis in educational materials is crucial for budget allocation and decision-making, it also promotes durability and long-term savings while minimizing costs and improving funds for other educational materials (Allison, 2019). Cost-effectiveness must be considered since it impacts the accessibility and suitability of an educational product or resources. This implies that prioritizing cost-effectivity can ensure that the resources will be efficiently utilized and can enhance the overall educational effectiveness of the product while achieving learning outcomes.

Theme 5: Product Enhancement Suggestions and Recommendations

The findings showed that the product's size, sound balance, visual elements, and functionality may all be improved with a couple of adjustments or modifications. This theme presents experts' collective

suggestions for enhancing the product's overall appearance, size, features, and audio components better to suit the needs of the user, especially the younger ones. It covers figuring out where the product could have defects and insufficiencies to yield better experience to the users. This provides helpful criticism to correct different product aspects and raise its appeal and also its performance.

Responses from the experts revealed that one of the product enhancement suggestions is the product functionality, which was based on the collective feedback from the participants. These suggestions are intended to improve the ease of use and overall user experience, making the product more practical and user-friendly. Before designing a product, such as a children's toy, the researchers must consider all of the tasks that users will perform with the final product. Physical and cognitive operations are the most deliberated categories of tasks from a human factors standpoint. These improvements prioritize user experience, reflecting a user-centered design approach focused on practicality and ease of use (Triebenbacher & Relations, 2012). These were supported by the responses of experts that:

Sped Teacher 3: "...so functionality niya is for addition only? It's also better if you add basic subtraction, pwede ra jud, if Addition abante ang train if subtraction paatras."

English Translation: "...So its functionality is only for addition? It would be better if you also add basic subtraction. It's possible, right? If addition makes the train move forward, subtraction should make it move backward."

Sped Teacher 4: "It's better if wheels in the train is functional." "...kailangan siya naay handle to make it convenient for the child to hold (referring to the white board)."

"...problema is if mawala ang mga item sa sulod. So e close lang jud ni siya permi."

English Translation: "It's better if the wheels on the train are functional."

"...it needs to have a handle to make it convenient for the child to hold (referring to the whiteboard)."

"...the problem is if the items inside get lost. So it should always be closed securely."

These responses indicate a desire for improvements to the addition game board with a focus on increasing functionality and usability. To provide a comprehensive mathematical learning experience, the experts suggest considering incorporating subtraction not just addition. The recommendation for functional wheels on the train component suggests a preference for interactive elements that encourage participation and imaginative play. This aligns with the purpose of interactive teaching materials to visualize abstract concepts (Abadi et al., 2017). Both put a lot of emphasis on interactive elements to draw students in and enhance understanding at the same time. Interactive teaching tools and functional wheels not only promote engagement and imaginative play, but also give learning a tangible, hands-on experience that improves comprehension and retention of challenging and abstract concepts.

In order to enhance convenience and minimize efforts of use for both teachers and students, the experts recommended adding handles to the board, underscoring the significance of ergonomic design. There is a correlation between the emphasis on instructional design quality as a critical indicator of successful learning and the concern over item loss in instructional materials. Just as effective instructional design is needed for successful learning, practical solutions such as secure locks or stoppers for closing the game board effectively are crucial for guaranteeing the longevity and effectiveness of educational materials

(Margaryan et al., 2015). These suggestions show that user-centered design is necessary for creating engaging and practical educational materials that enhance effective teaching and learning environments. The experts' responses on the enhancement of the game board's visual features is another product enhancement suggestions theme that includes ideas and recommendations to make educational materials more visually appealing and functional. By improving learners' visual experiences, these recommendations hope to increase the effectiveness and engagement of instructional materials. These were supported by the responses of experts that:

Gen-Ed Teacher 1: "Number pegs should be visible."

Gen-Ed Teacher 2 and 4, Sped Teacher 3, and Engineer 2: "The wood train is excellent and well-made, but painting it with color would enhance its attractiveness."

Gen-Ed Teacher 4: "...[Add] red-blue lines sa whiteboard..."
English Translation: "[Add] red-blue lines to the whiteboard."

Sped Teacher 4: "...too much light is distracting to the students, mas maayo is usa ra siya (referring to the light)."

English Translation: "...too much light is distracting to the students, it's better if there's only one (referring to the light)."

Engineer 4: "I noticed it lacked visual appeal and design. Consider incorporating graphics around the board's exterior to enhance aesthetics and excitement for users."

These responses from the teachers and engineers collectively emphasize the importance of visual enhancements in educational settings to facilitate effective teaching and learning experiences. According to Shabiralyani et al. (2015), Visual aids are essential tools in education, assisting teachers in explaining concepts and capturing students' attention. They include a variety of instructional aids used in classrooms to improve learning outcomes, such as pictures, models, charts, maps, videos, slides, and real objects. According to Burton and Kinder, visual aids stimulate and support learning by presenting sensory objects or images and making learning experiences more realistic and interactive. Beginning with the suggestion to ensure the visibility of number pegs, the focus is on providing clear and accessible learning resources that allow students to easily engage with mathematical concepts. The suggestions for adding color to the wooden train toy emphasize the importance of aesthetic appeal in fostering student interest and enjoyment during play-based learning activities.

Incorporating blue-red-blue lines on the whiteboard is also recommended for students to be guided in writing their answers. This does not only develop their fine motor skills but also their handwriting skills. The study of Ocampo et al. (2017), revealed that the use of blue-red-blue lines is stressed in order to enhance writing skills when addressing the writing needs of first-grade students, with a particular focus on neatness, readability, and maintaining appropriate spacing between letters and words. Recommendations for visual aids and lighting concerns demonstrate efforts to improve focus.

Based on the insights of the experts, the size and material of the product should also be enhanced and improved to better suit the needs of learners. The experts recommended upsizing the magnetic detachable

whiteboard for space efficiency and ease of use, as well as exploring lightweight materials instead of traditional wooden layers for the board. These were supported by the responses of experts that:

Gen-Ed Teacher 1: "Detachable magnetic whiteboard should be bigger."

Gen-Ed Teacher 2: "The whiteboard needs a little bit of upsizing and ensuring that the material used is sturdy enough for it to last longer."

Gen-Ed Teacher 4: "Dako ra kaayu ang board niya bug.at sad siya, siguro need lang ug ipa lightweight ang materials, dili lang wood ang gi layer sa sulod sa board like cardboard ba ron ana."

English Translation: "The board is too big and heavy. Maybe it just needs to be made of lightweight materials, not just wood layers inside the board, like cardboard perhaps."

Sped Teacher 3: "...dako kaayu siya. Mu occupy siyag too much space (referring to the board)... "dapat ang butanganan sa dice Kay dako siya gamay, aron mas wide ig roll sa bata."

English Translation: "It's really big. It takes up too much space. The dice container should be bigger so that the dice are larger, allowing for a wider roll for the child."

Engineer 2: "...too heavy and big to be carried by teachers (referring to the board)."

These responses from the experts suggest that the current size and material of the board may not be optimal for efficient use in educational settings, enhancement to improve the product is needed to enhance functionality and usability. Educational materials are important in facilitating effective teaching and independent learning. It emphasizes the need for educational materials to be explicit, well-organized, and conducive to increasing student engagement and activity (Mazgon and Stefanc, 2012). This response highlights to explores the impact of the appropriate size and durability of the instructional material on student engagement and learning. This implies that developers should explore a design of the products that should be in appropriate size, and user-friendly to support effective teaching experience among learners.

The results showed that sound balance should be considered as one of the components that need to be enhanced according to the collective responses of the experts. The experts express various opinions such as potential irritation or discomforts caused by loud or prolonged sound, especially for learners with auditory sensitiveness. These were supported by the responses of experts that:

Gen-Ed Teacher 1: "... sound should not be too loud or long."

Gen-Ed Teacher 2: "Having sound effects for correct answers is a nice idea, but it can be irritating to the ears."

Gen-Ed Teacher 3: "Dili e prolong ang pag buzz s sound inig tumong sa trai kay saba."

English Translation: "Do not prolong the buzzing sound when aiming at the tray because it's loud."

Gen-Ed Teacher 4: "...sa sound, mas better if dili ra buzz, sound lang sa number aron makat-on jud ang bata."

English Translation: "...for the sound, it's better if it's just a sound of the number instead of buzzing, to help the child learn the numbers properly."

SpEd Teacher 3: "dili ni siya pwede sa ASD Kay naay bata na sensitive in terms of sound."

English Translation: "this is not suitable for ASD because there are children who are sensitive to sound."

According to the experts, while sound effects can enhance learning engagement, their use should be carefully moderated to avoid discomfort or distractions for learners with sensory sensitivities. Additionally, the experts also suggested that utilizing sound effects should aid number recognition rather than integrating unnecessary noises. The academic success of students is influenced by their attentional and sensorial processing abilities, which is why understanding these factors is crucial for designing effective interventions to support student success (Weinschreider, 2020). This emphasizes how important it is to consider inclusive and accessible educational materials to meet the diverse needs and sensory sensitivities of certain learners. This implies that balancing sound effects to enhance engagement is important, and developers should consider adopting inclusive materials and designs to enhance holistic learning among young learners.

4.0 Conclusion and Recommendation

[+]The study concludes that the MATHEXpress Addition Game Board effectively stimulates engagement and can be used as a valuable tool for teaching number recognition and basic addition skills to kindergarten to grade 1 learners, including those with special needs, promoting active engagement and cognitive development. The study also reveals that the game board as a whole is durable and user-friendly. While some of its components, such as dice and number pegs, are found to be easy to manipulate, enhancing its suitability for young users, experts suggest prioritizing age-appropriate materials, such as plastic dice, and adhering to size recommendations to prevent choking hazards. However, while the game board is highly engaging for early childhood education learners both in general and special education classrooms, it is not suitable for learners with intellectual disabilities at lower levels but is highly suitable for those learners with intellectual disabilities at higher levels. In terms of safety and suitability, experts recommended implementing more edge smoothing and stoppers to prevent potential accidents. Furthermore, this study emphasizes the importance of supervision during play to prevent potential injuries. Moreover, the results revealed the importance of prioritizing cost-effectiveness in the development and selection of the product's materials and further recommend using rechargeable batteries rather than disposable ones to save financially.

In addition, experts pointed out several key areas for enhancing the product's appeal and effectiveness in educational settings. These include: incorporating basic subtraction alongside addition; adding interactive elements such as functional wheels on the train; considering practical design features such as handles on the board for convenience; enhancing engagement and comprehension through the use of color and tracing lines; modulating sound effects to prevent irritation or discomfort, particularly for learners with auditory sensitivities; and utilizing number sounds instead of buzzing to help learners recognize numbers effectively. As a result, the researchers recommend that future efforts for the development of the product should utilize both feasibility and product evaluation testing to fully measure the effectiveness of the product.

5.0 References

1. Allison, C. (2019). *Cost Effectiveness in Education Methodology, Examples, Use of Cost-Effectiveness Analysis*. Sources Restrived from: <https://www.research.fsu.edu/media/5382/methodology-examples-use-of-cost-effectiveness-analysis.pdf>
2. *APA Dictionary of Psychology*. (2018). <https://dictionary.apa.org/pretest-posttest-design>
3. Adibsereshki, N., Tajrishi, M. P., & Zilaey, S. (2017). Attention Program and Math Performance of Students With Intellectual Disability. *Iranian Rehabilitation Journal*. https://irj.uswr.ac.ir/browse.php?a_id=759&sid=1&slc_lang=en&html=1
4. Bhandari, P. (2023, June 21). *Descriptive Statistics | Definitions, types, Examples*. Scribbr. <https://www.scribbr.com/statistics/descriptive-statistics/>
5. Bragg, L., Russo, J. & Russo, T. (2020). How primary teachers use games to support their teaching of mathematics. *International Electronic Journal of Elementary Education*. <https://files.eric.ed.gov/fulltext/EJ1297981.pdf>
6. Cheung, S. K., Dulay, K. M., & McBride, C. (2020). Parents' characteristics, the home environment, and children's numeracy skills: How are they related in low- to middle-income families in the Philippines? *Journal of Experimental Child Psychology*, 192, 104780. <https://doi.org/10.1016/j.jecp.2019.104780>
7. Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1. <https://doi.org/10.11648/j.ajtas.20160501.11>
8. Gafoor, K. A. (2015). Why high school students feel mathematics difficult? An exploration of affective beliefs. <https://eric.ed.gov/?id=ED560266>George, T. (2023). Semi-Structured Interview | Definition, Guide & Examples. Scribbr. https://www.scribbr.com/methodology/semi-structured-interview/?fbclid=IwAR0J07Sqoxznqy4_BCdxfwPjpn1xENPVcuVwPeCKcRkIYhPdo2t73APQL6Q
9. Guhl, P. (2019). The impact of early math and numeracy skills on academic achievement in elementary school. NWCommons. https://nwcommons.nwciowa.edu/education_masters/155/
10. Guobin, Z. & Minxuan, L. (2021). Game box capable of assembling as chess board. Google Patents. [https://patents.google.com/patent/TWM615665U/en?q=\(Wooden+board+game\)&oq=+Wooden+board+game](https://patents.google.com/patent/TWM615665U/en?q=(Wooden+board+game)&oq=+Wooden+board+game)
11. Pennant, J. (2018). *Using dice games in the classroom*. <https://nrch.maths.org/8414>
12. Iannelli, V., MD. (2021, February 10). How to choose safe toys for your kids. Verywell Family. <https://www.verywellfamily.com/toy-safety-choosing-safe-toys-2634223>
13. Jowsey, T., Deng, C., & Weller, J. (2021). General-purpose thematic analysis: a useful qualitative method for anaesthesia research. *BJA Education*, 21(12), 472–478. <https://doi.org/10.1016/j.bjae.2021.07.006>
14. Rai, N., & Thapa, B. (2015). A study on purposive sampling method in research. *Kathmandu: Kathmandu School of Law*, 5.
15. Karamert, Ö., & Vardar, A. K. (2021). The effect of gamification on young mathematics learners' achievements and attitudes. *Journal of Educational Technology and Online Learning*, 4(2), 96–114. <https://doi.org/10.31681/jetol.904704>
16. Kim, B. (2015). Gamification in education and libraries. *Library Technology Reports*, 51(2), 20–28. Retrieved from <https://journals.ala.org/index.php/ltr/article/view/5631/6951>Cached

16. Krinzing, H., Kaufmann, L., & Willmes, K. (2009). Math anxiety and math ability in early primary school years. *Journal of Psychoeducational Assessment*, 27(3), 206–225. <https://doi.org/10.1177/0734282908330583>
17. Kunwar, R., Shrestha, B. K., & Sharma, L. (2021). Are Teachers Aware of Mathematics Learning Disabilities? Reflections from Basic Level Schoolteachers of Nepal. *European Journal of Educational Research*, 10(1), 367–380. <https://doi.org/10.12973/eu-jer.10.1.367>
18. Langoban, M. (2020). What Makes Mathematics Difficult as a Subject for most Students in Higher Education? *ResearchGate*. https://www.researchgate.net/publication/342888714_What_Makes_Mathematics_Difficult_as_a_Subject_for_most_Students_in_Higher_Education
19. Mallory, C. L., & Keehn, B. (2021). Implications of sensory processing and attentional differences associated with autism in Academic settings: an Integrative review. *Frontiers in Psychiatry*, 12. <https://doi.org/10.3389/fpsy.2021.695825>
20. Margaryan, A., Bianco, M., & Littlejohn, A. (2015). Instructional quality of Massive Open Online Courses (MOOCs). *Computers & Education*, 80, 77–83. <https://doi.org/10.1016/j.compedu.2014.08.005>
21. Miami University. (2021, December 11). *Game Mechanics Research Paper: Dice Rolling | Tabletop Leadership*. <https://sites.miamioh.edu/tabletop/2021/12/game-mechanics-research-paper-dice-rolling/?fbclid=IwAR0NdbULXu4wU3YsmGckLRA5hRf5ybKveVhHn4TSoCrGin7bO6FAS4NS1KM>
22. Mironcika, S., De Schipper, A., Brons, A., Toussaint, H., Kröse, B., & Schouten, B. (2018). Smart Toys Design Opportunities for Measuring Children’s Fine Motor Skills Development. *Association for Computing Machinery Digital Library*. <https://doi.org/10.1145/3173225.3173256>
23. Mittal, N. (2023, March 27). *Why is it important to understand your target market?* Scaling Partners. <https://rb.gy/cf4s7i>
24. Mononen, R. (2019). Mathematical learning difficulties | iSeeNumbers. iSeeNumbers. <https://www.iseenumbers123.com/mathematical-learning-difficulties?fbclid=IwAR2Qm4xEYRIzWVyojFGmdyw9C8LZdOijpitNCyUoSrmQ2X2z1Vp01S1tA7Q>
25. Montemayor, Ma. T. (2023, December). *CHED to address PH students’ low int’l assessment ranking*. Philippine News Agency. Retrieved February 2, 2024, from <https://www.pna.gov.ph/articles/1215002#:~:text=According%20to%20the%202022%20PISA,an%20average%20score%20of%20347>. Regoniel, P. (2024, January 14). *Descriptive Qualitative Research: A brief guide*. Research-based Articles. <https://simplyeducate.me/2023/04/10/descriptive-qualitative-research/>
26. Noda, S., Shirotaki, K., & Nakao, M. (2019). The effectiveness of intervention with board games: a systematic review. *BioPsychoSocial Medicine*, 13(1). <https://doi.org/10.1186/s13030-019-0164-1>
27. Ocampo, J. M., Varela, L. P., & Ocampo, L. V. (2017F). Effectiveness of brain gym activities in enhancing writing performance of Grade I pupils. *Sosiohumanika*, 10(2), 179–190. <https://doi.org/10.2121/sosiohumanika.v10i2.919>
28. Ojating, Henry and Ojating, Jane Henry (2022) Incorporating Tangible Instructional Materials in Teaching and Learning: Implications for Educational Assessment and Evaluation. *International*

- Journal of Quantitative and Qualitative Research Methods, 10 (1). pp. 1-6. ISSN 2056-3620(Print), 2056-3639(Online)
29. Ompok, C., C., et al. (2021). EFFECT OF GAMES TOWARDS CHILDREN'S MATHEMATICS PERFORMANCE. *Southeast Asia Early Childhood Journal*, Vol. 10 (1), 2021 (1-17)(ISSN 2289-3156), eISSN 2550-1763. <https://files.eric.ed.gov/fulltext/EJ1296276.pdf> Pezalla, A. E. (2012). Researching the researcher-as-instrument: an exercise in interviewer self-reflexivity. *PubMed Central (PMC)*. <https://doi.org/10.1177/1487941111422107>
 30. Özcan, B., Sperati, V., Giocondo, F., Schembri, M., & Baldassarre, G. (2022). Interactive soft toys to support social engagement through sensory-motor plays in early intervention of kids with special needs. *Interaction Design and Children*. <https://doi.org/10.1145/3501712.3535274>
 31. Polo-Blanco, I., & López, E. M. G. (2021). Teaching addition strategies to students with learning difficulties. *Autism & Developmental Language Impairments*, 6, 239694152110453. <https://doi.org/10.1177/23969415211045324>
 32. Rondina, J. Q., & Roble, D. B. (2019). GAME-BASED DESIGN MATHEMATICS ACTIVITIES AND STUDENTS' LEARNING GAINS. *Turkish Online Journal of Design, Art and Communication*, 9(1), 1–7. <https://doi.org/10.7456/10901100/001>
 33. Rosala, M. (2024, January 19). *How many participants for a UX interview?* Nielsen Norman Group. <https://www.nngroup.com/articles/interview-sample-size/>
 34. Samuel, H. (2023). The psychology of board games: how they engage our minds. Medium. <https://hayessamuel.medium.com/the-psychology-of-board-games-how-they-engage-our-minds-bc8c391cf124>
 35. Silver, A. M., & Libertus, M. E. (2022). Environmental influences on mathematics performance in early childhood. *Nature Reviews Psychology*, 1(7), 407–418. <https://doi.org/10.1038/s44159-022-00061-z>
 36. Stanley, R. (2021, September 8). *Why Is Math so Hard for Some Students?* Prodigy. <https://www.prodigygame.com/main-en/blog/math-is-hard/>
 37. Syahputri, V. N., Idami, Z., Putri, Z., & Kurniasy, D. (2020). WHITEBOARDS IN PEDAGOGICAL SETTINGS: LEAVE IT OR USE IT? *Humanities & Social Sciences Reviews*, 8(3), 11–19. <https://doi.org/10.18510/hssr.2020.832>
 38. Team, U. (2023, November 27). What is dyscalculia? Understood. <https://www.understood.org/en/articles/what-is-dyscalculia>
 39. The Department of Defense Child Development Virtual Laboratory School. (2023). *Providing safe games and learning materials | Virtual lab school*. <https://www.virtuallabschool.org/school-age/safe-environments/lesson-2>
 40. Tlili, A., Denden, M., Duan, A., Padilla-Zea, N., Huang, R., Sun, T., & Burgos, D. (2022). Game-Based Learning For Learners With Disabilities—What is next? A Systematic Literature Review from the Activity Theory perspective. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.814691>
 41. Toys and games for children. (2023, April 13). Raising Children Network. <https://raisingchildren.net.au/babies/play-learning/getting-play-started/toys-and-games>
 42. Triebenbacher, S., & Relations, C. D. a. F. (2012). Child Development Knowledge and Human Factors in Toy Design : An exploratory study of popular children's products. <http://hdl.handle.net/10342/4024>

- 43. Vogelsang, K. (1994). Method for playing a dice game. Google Patents. [https://patents.google.com/patent/US5425537A/en?q=\(Rolling+dice\)&oq=Rolling+dice](https://patents.google.com/patent/US5425537A/en?q=(Rolling+dice)&oq=Rolling+dice)
- 44. Wallace, M., Odom, P. T., & Llc, P. I. (2008, June 20). *US8517383B2 - Interactive game board system incorporating capacitive sensing and identification of game pieces* - Google Patents. [https://patents.google.com/patent/US8517383B2/en?q=\(gameboard+buzzer\)&oq=gameboard+with+buzzer](https://patents.google.com/patent/US8517383B2/en?q=(gameboard+buzzer)&oq=gameboard+with+buzzer)
- 45. Weinschreider, C. (2020). Comfort is critical for student success. Here are 3 simple factors to consider. -- Spaces4Learning. Spaces4Learning. <https://spaces4learning.com/articles/2020/05/25/comfort-is-critical-for-student-success.-here-are-3-simple-factors-to-consider.aspx>
- 46. Young, Alanna Bjorklund. “High-Quality Curricula: A Cost-Effective Way to Increase Student Learning.” Accessed January 20, 2020. <https://edpolicy.education.jhu.edu/high-quality-curricula-a-cost-effective-way-to-increase-student-learning/> (opens in new window).

APPENDIX A

Qualitative Interview Questions Teacher Perspectives on Addition Train Boards in Mathematics

Section 1: General Information

- 1.1. Name of Teacher (Optional): _____
- 1.2. Grade/Level Taught: _____
- 1.3. Years of Teaching Experience: _____

Section 2: Perspectives on Addition Train Boards

- 2.1. What are your thoughts on the various components of the product such as:

2.1.1. Die

2.1.2. Board

2.1.3. Train

2.1.4. Number pergs

2.1.5. Detachable whiteboard

2.1.6. Lights and Sound

2.2. How do you evaluate the functionality of the product as a whole?

2.3. In your opinion, how creative or innovative is the product?

2.4. Do you believe the product is relevant to its intended audience?

2.5. What are your thoughts regarding the safety aspects of the product?

Section 3: Suggested Improvements of the Product

3.1. What specific improvements can be made to the product?

APPENDIX B

**Qualitative Interview Questions
Engineers' Perspectives on Addition Train Boards**

Section 1: General Information

- 1.1 Name (Optional): _____
- 1.2. Industry Specialization: _____
- 1.3. Years of Experience: _____

Section 2: Engineers' Perspectives on Addition Train Boards

2.1. What are your thoughts on the various components of the product such as:

2.1.1. Dice:

-

How durable do you find the material of the die? _____

-

-

Is the size appropriate for safe use by children? _____

-

2.1.2. Board:

-

Does the board withstand regular use? _____

-

-

Are the printing and design clear and conducive to learning? _____

-

2.1.3. Train:

-

Is the train well-built and resistant to damage? _____

-

-

Does the train effectively engage children in learning activities? _____

-

2.1.4. Number pegs:

-

Are the number pegs securely attached to the board? _____

-

-

Are they of appropriate size and shape for young children to handle? _____

-

2.1.5. Lights and Sound:

-

Are they properly installed? _____

-

-

Are they durable and resistant to wear and tear? _____

-

2.2. Electronics and Functionality

-

What are your thoughts on the reliability and durability of the electronic components used in the product? _____

-
-

Are there any notable functional shortcomings or areas for improvement? _____

-
-

How do you evaluate the functionality of the product as a whole? _____

-

2.3. Creativeness and Innovativeness

-

Does the product offer unique features or approaches to learning? _____

-

2.4. Intended Audience

-

Do you believe the product is relevant to its intended audience? _____

-

2.5. What are your thoughts regarding the safety aspects of the product?

-

Are there any potential safety hazards associated with the design or components? _____

-
-

Does the product meet relevant safety standards and regulations? _____

-

Section 3: Suggested Improvements of the Product

3.1. What are your suggestions or advice for further development or refinement of the gameboard? _____

APPENDIX C

CERTIFICATE OF PRODUCT VALIDITY

This is to certify that I have checked and advised necessary changes to the product to be used by your researcher namely, Alma Flores, Renashel Condrillon, and Rhea Cassandra Tisoy for their research entitled **“Inclusive Addition Train Board: Exploring Gamification in Learning Mathematics.”**

I fully certify that I am an authority in this subject presented before me in this study. As an expert in this subject/topic, I have reviewed and validated the contents of the product.

CERTIFIED BY:



ENGR. WELVEN B. AGUA
Research Adviser & Consultant
CTU- Argao Campus



JACQUELINE K. SO
Graduate of Bachelor of Science Major in Civil Engineering



ALLEN M. FLORES
Graduate of Bachelor of Industrial Technology Major in Electrical Technology
Electrical Maintenance in CTU Consolacion