ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 9| September 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

MATHEMATICAL PERCEPTION IN THE DIGITAL AGE: EXPLORING THE IMPLICATIONS OF VISUALIZATION AND GAMIFICATION ON NUMERICAL INTUITION AND NUMERICAL REASONING

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ABSTRACT

This study aims to comprehensively analyze the mathematical perception of the digital age: exploring the implications of visualization and gamification on numerical intuition and numerical reasoning. The research focuses on determining the level of visualization; gamification; numerical intuition and reasoning. It measures the significant relationship between the visualization and gamification on the numerical intuition and reasoning.

Utilizing a descriptive correlational method, data is gathered from a survey questionnaire-checklist administered to randomly selected Grade 11 students at San Pedro Relocation Center National High School. Statistical analyses, including frequency, mean, standard deviation, and Pearson correlation, are employed to interpret the collected data.

The exploration revealed several significant findings: Firstly, the level of visualization, including graphs, illustrations, concept maps, and pictures, is very high. Secondly, the level of gamification, encompassing collaboration, mechanics, reward systems, content, and feedback, is also very high. Thirdly, the level of numerical intuition, involving a sense of numbers, relationships, and patterns, is very high. Fourthly, the level of numerical reasoning, including logical inference, analogical reasoning, and decision-making, is also very high. Fifth, the study indicates a significant positive moderate relationship between visualization and gamification on numerical intuition and reasoning.

It is concluded that the visualization and gamification has significant relationship on the numerical intuition and reasoning, therefore, the hypotheses were both rejected. It signifies that both methods engage different cognitive processes that complement each other, thereby enhancing mathematical skills. Visualization and gamification strategies may work together to activate multiple cognitive functions related to numerical processing, resulting in increased numerical intuition and reasoning abilities.

The study led to several key recommendations. It is advised that teachers continue to incorporate visualization and gamification in their teaching methods to maintain student motivation and enhance academic performance. Schools are encouraged to develop curricula that cater to the diverse interests and abilities of their students. Future researchers are encouraged to use this study as a source of inspiration and motivation.

KEYWORDS: *mathematical perception; digital age; mplications of visualization*

1. INTRODUCTION

In the ever-evolving landscape of education, the integration of technology has become increasingly ubiquitous, offering novel opportunities to reshape pedagogical approaches. The study on "Mathematical Perception in the Digital Age: Exploring the Implications of Visualization and Gamification on Numerical Intuition and Numerical Reasoning" was motivated by the pressing need to understand and harness the transformative potential of emerging digital tools in the realm of mathematical learning.

This study was prompted by the imperative to investigate the transformative potential of visualization and gamification in mathematics education and was underscored by foundational research and theoretical frameworks that highlight the critical need for innovative approaches to address challenges in mathematical learning.

The integration of technology into education has been recognized as a transformative force, Prensky, M. (2001). As the digital age is navigated understanding how digital tools, specifically visualization and gamification, influence the learning of mathematics becomes crucial. The work of Prensky emphasizes the necessity of adapting education to the digital native generation, urging exploration into novel instructional strategies.

According to National Research Council (2001), mathematics education often faces challenges related to abstract concepts and student engagement. Hohenwarter, M., & Jones, K. (2007) stated that visualization has been identified as a powerful tool to make abstract concepts more concrete and accessible. The study aligns with the recommendations of the National Council of Teachers of Mathematics, advocating for the integration of visual representation to enhance mathematical understanding, NCTM (2001).

Visualization and gamification cater to diverse learning styles, Gee, J. P. (2003). Inclusivity in education is a paramount concern, and these digital tools offer avenues to make mathematical learning more accessible to a broad spectrum of learners, Salend, S. J. (2016). The study harmonizes with inclusive education principles outlined in the work of UNESCO (2019) that emphasized visualization and gamification. By adopting these innovative approaches, educators can foster inclusive environments where all students can thrive for excellence.

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While there is recognition of the potential benefits of visualization and gamification in mathematics education, empirical evidence is essential for informed pedagogical decisions, Hattie, J. (2009). This study seeks to contribute to the empirical knowledge base, aligning with the evidence-based practice paradigm advocated by educational researchers, Brown, C. A. (2009).

The rapid evolution of educational technology necessitates ongoing research to stay abreast of the effectiveness of emerging tools, Dede, C. (2008). The study aligns with the perspective that educational research must adapt to leverage technology's potential. By doing so, we enhance instructional practices, empower educators, and create meaningful learning experiences. Mishra, P., & Koehler, M. J. (2006).

It is deeply rooted in the acknowledgment of the transformative potential of digital strategies like visualization and gamification to provide valuable insights into that can contribute to the enhancement of mathematics education.

1.1 Statement of the Problem

It sought to answer the following questions:

1. What is the level of visualization in terms of:
    - 1.1 Graphs;
    - 1.2 Simulations;
    - 1.3 Illustrations;
    - 1.4 Concept Maps; and
    - 1.5 Pictures?
2. What is the level of gamification in terms of:
    - 2.1 Collaboration;
    - 2.2 Mechanics;
    - 2.3 Reward System;
    - 2.4 Content; and
    - 2.5 Feedback?
3. What is the level of numerical intuition in terms of:
    - 3.1 Sense of numbers;
    - 3.2 Relationships; and
    - 3.3 Patterns?
4. What is the level of numerical reasoning in terms of:
    - 4.1 Logical inference;
    - 4.2 Analogical; and
    - 4.3 Decision-making?
5. Is there a significant relationship between the visualization on the Numerical Intuition and Numerical Reasoning?
6. Is there a significant relationship between the gamification on the Numerical Intuition and Numerical Reasoning?

2. METHODOLOGY

The research design used in this study was a Descriptive Correlational method of research. Descriptive correlational research design is a type of quantitative research design that aims to determine the relationships between things that involves gathering data through surveys or observational methods to examine the relationships between variables. As Öztürk, M., Akkan, Y., & Kaplan, A. (2020) analyze the link between factors and non-routine problem-solving skills was investigated using hierarchical regression, as were the predictive effects of the predictor variables on non-routine Mathematics problem-solving skills.

Surveys are efficient for collecting information about individuals' experiences, beliefs, and attitudes, while observation involves observing video recordings or using the experience sampling method to gather real-time data on participants' experiences.

3. RESULTS AND DISCUSSION

This chapter deals with the presentation, interpretation, and analysis of data. This involves processing and examining the collected data to extract meaningful insights. Simultaneously, data interpretation was done that aims to draw sensible conclusions. This also focuses on data presentation that involves effective communication of the research findings in a clear and concise manner.

In this chapter, the researcher delved into the results obtained from his study, analyzed them quantitatively, and interpret their implications to address the research questions and test hypotheses effectively.

Level of Visualization

This explores the Level of Visualization across various modes of representation in terms of graphs, simulations, illustrations, concept maps, and pictures, where each form offers unique insights.

Additionally, the results are represented through tables to examine the statistical aspects using mean, standard deviation, and verbal interpretation.

Level of Visualization in terms of Graphs

Table 1 shows the level of visualization in terms of graphs. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Students affirmed that effective graphical representation enhances the understanding of complex data sets. The mean (M = 4.80) with standard deviation (SD = 0.82) suggests a *very high* level of visualization in terms of graphs. However, being proficient in creating graphs using data visualization tools or software was agreed by the students. While the mean is slightly lower (M = 4.03) with standard deviation (SD = 0.78), it still indicates a good visualization level with the use of graphs. The level of visualization in terms of graphs attained a weighted mean score of 4.37 and a standard deviation of 1.10 and was verbally interpreted as *very high* among the respondents.

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Table 1. **Level of Visualization in terms of Graphs**

STATEMENT	*MEAN*	*SD*	*REMARKS*
I feel confident in selecting the most appropriate type of graph to represent different types of data.	4.51	0.54	Strongly Agree
I am proficient in creating graphs using data visualization tools or software (e.g., Excel, Tableau, etc.).	4.03	0.78	Agree
I am comfortable interpreting information presented in graphical form, such as charts and graphs.	4.20	0.57	Strongly Agree
I can easily identify patterns, trends, or outliers in data when presented graphically.	4.34	0.49	Strongly Agree
I believed that effective graphical representation enhances the understanding of complex data sets.	4.80	0.82	Strongly Agree
Weighted Mean	*4.37*		
SD	*1.10*		
Verbal Interpretation	*Very High*		

In the results, it may observe that, students feel confident in selecting a graph to represent a data, they are proficient in creating graphs using data visualization tools or software, comfortable interpreting information presented in graphical form, can easily identify patterns, trends, or outliers and they believed on the effectivity of graphical representation in enhancing understanding of complex data sets.

Level of Visualization in terms of Simulations

Table 2 shows the level of visualization in terms of simulations. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Table 2. **Level of Visualization in terms of Simulations**

STATEMENT	*MEAN*	*SD*	*REMARKS*
I feel confident in understanding and navigating simulations to gain meaningful insights.	4.50	1.09	Strongly Agree
I am proficient in utilizing simulation tools or software to visualize and analyze complex scenarios.	4.09	1.01	Agree
I am comfortable interpreting information presented through simulations.	4.32	1.09	Agree
I can easily identify patterns, trends, or key insights when presented with data through simulations.	4.11	1.01	Agree
I believe that the use of simulations enhances the comprehension of complex concepts or systems.	4.46	1.13	Strongly Agree
Weighted Mean	*4.30*		
SD	*1.08*		
Verbal Interpretation	*Very High*		

Students feel confident in understanding and navigating simulations to gain meaningful insights. The mean (M = 4.50) with standard deviation (SD = 1.09) suggests a *very high* level of visualization in terms of simulations. However, being proficient in utilizing simulation tools or software to visualize and analyze complex scenarios was partly agreed by the students. While the mean is slightly lower (M = 4.09) with standard deviation (SD = 1.01), is still indicates a good level of visualization using simulation and implies that learners can analyze and understand scenarios comfortably using simulations.

The level of visualization in terms of simulations attained a weighted mean score of 4.30 and a standard deviation of 1.08 and was verbally interpreted as *very high* among the respondents.

Therefore, students are confident in understanding and navigating simulations and are proficient in utilizing simulation tools or software. They find it easier to interpret information, identify patterns, trends, or key insight, and enhances the comprehension of complex concepts or systems that are presented through simulations.

Level of Visualization in terms of Illustrations

Table 3 shows the level of visualization in terms of illustrations. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation

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.Table 3. **Level of Visualization in terms of Illustrations**

STATEMENT	*MEAN*	*SD*	*REMARKS*
I feel confident in presenting data through illustrations.	4.53	1.28	Strongly Agree
I am proficient in interpreting illustrations to communicate the necessary data needed.	4.27	1.06	Strongly Agree
I am comfortable interpreting information presented through illustrations.	4.45	1.17	Strongly Agree
I can easily interpret data by means of illustrations.	4.20	1.17	Strongly Agree
I believed that illustration can aide to better understanding of the concept.	4.53	1.21	Strongly Agree
Weighted Mean	*4.39*		
SD	*1.19*		
Verbal Interpretation	*Very High*		

Students are comfortable in presenting facts through images, and they believe that illustrations can help them better understand the idea. The mean (M = 4.53) with standard deviation (SD = 1.28 and 1.21, respectively) suggests a *very high* level of visualization in terms of illustrations. However, being students that can easily interpret data by means of illustrations was partly agreed by the students. While the mean is slightly lower (M = 4.20) with standard deviation (SD = 1.17), it still indicates a good level of visualization and means that the learners comfortable enough to use illustrations for data interpretation. The level of visualization in terms of illustrations attained a weighted mean score of 4.39 and a standard deviation of 1.19 and was verbally interpreted as *very high* among the respondents.

Level of Visualization in terms of Concept Maps

Table 4 shows the level of visualization in terms of concept maps. It also shows the statements, mean, standard deviation, remarks and verbal interpretation.

Students believed that concept maps are effective tools to enhance the understanding of interconnected concepts. The mean (M = 4.53) with standard deviation (SD = 1.16) suggests a *very high* level of visualization in terms of concept maps.

However, being proficient in using concept mapping tools or software to visualize complex ideas or topics was partly agreed by the students. The mean is slightly lower (M = 4.20) with standard deviation (SD = 1.06), but it still indicates a good visualization level and implies that learners can still improve in using concept maps to better understand complex ideas or topics. The level of visualization in terms of graphs attained a weighted mean score of 4.35 and a standard deviation of 1.12 and was verbally interpreted as *very high* among the respondents.

Table 4. **Level of Visualization in terms of Concept Maps**

STATEMENT	*MEAN*	*SD*	*REMARKS*
I feel confident in creating my own concept maps to represent and organize information.	4.44	1.13	Strongly Agree
I am proficient in using concept mapping tools or software to visualize complex ideas or topics.	4.20	1.06	Strongly Agree
I am comfortable interpreting information presented through concept maps.	4.29	1.12	Strongly Agree
I can easily identify relationships and connections between concepts in a concept map.	4.28	1.10	Strongly Agree
I believe that concept maps are an effective tool for enhancing understanding of interconnected concepts.	4.53	1.16	Strongly Agree
Weighted Mean	*4.35*		
SD	*1.12*		
Verbal Interpretation	*Very High*		

Students feel confident in creating own concept maps, they are proficient in using concept mapping tools or software, comfortable interpreting information presented through concept maps, can easily identify relationships and connections between concepts in a concept map, and the believed that concept maps are an effective tool for enhancing understanding of interconnected concepts.

Level of Visualization in terms of Pictures

Table 5 shows the level of visualization in terms of pictures. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

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Table 5. **Level of Visualization in terms of Pictures**

STATEMENT	*MEAN*	*SD*	*REMARKS*
I feel confident in analyzing and extracting information conveyed through visual elements in pictures.	4.66	1.12	Strongly Agree
I am proficient in creating visual content or presentations using pictures to convey ideas.	4.48	1.11	Strongly Agree
I am comfortable interpreting information presented through pictures.	4.51	1.18	Strongly Agree
I can easily derive meaning and context from pictures, graphs, or visual representations.	4.50	1.08	Strongly Agree
I believed that the use of pictures enhances the overall understanding of information compared to text alone.	4.58	1.25	Strongly Agree
Weighted Mean	*4.54*		
SD	*1.15*		
Verbal Interpretation	*Very High*		

Students feel confident in analyzing and extracting information conveyed through visual elements in pictures. The mean (M = 4.66) with standard deviation (SD = 1.12) suggests a *very high* level of visualization in terms of concept maps. However, being proficient in creating visual content or presentations using pictures to convey ideas was partly agreed by the students. The mean is slightly lower (M = 4.48) with standard deviation (SD = 1.11), but it still indicates a good visualization level and implies that the learners can understand and express ideas using pictures.

The level of visualization in terms of pictures attained a weighted mean score of 4.54 and a standard deviation of 1.15 and was verbally interpreted as *very high* among the respondents.

This may infer that, students feel confident in analyzing and extracting information conveyed through visual elements in pictures, they are proficient in creating visual content or presentations using pictures to convey ideas, comfortable interpreting information presented through pictures, can easily derive meaning context, and they believed that the use of pictures enhances the overall understanding of information compared to text alone.

Level of Gamification

Gamification, the art of applying game elements to non-game contexts, has gained significant attention through diverse domains. This probes the Level of Gamification in terms of collaboration, mechanics, reward system, content, and feedback.

Moreover, the results are represented through tables to examine the statistical aspects using mean, standard deviation, and verbal interpretation.

Level of Gamification in terms of Collaboration

Table 6 shows the level of gamification in terms of collaboration. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

The students agreed that collaborative tasks with gamified elements contribute to a more enjoyable and interactive teamwork experience. The mean (M = 4.78) with standard deviation (SD = 1.04) suggests a *very high* level of gamification in terms of collaboration.

However, the students partly agreed that gamification enhances a team's motivation to actively participate in collaborative projects. While the mean is slightly lower (M = 4.52) with standard deviation (SD = 1.15), it still indicates through students' collaboration during gamification they became more participative and motivated to learn.

Table 6. **Level of Gamification in terms of Collaboration**

STATEMENT	*MEAN*	*SD*	*REMARKS*
Gamification aspects in students' collaborative activities increase team engagement.	4.64	1.02	Strongly Agree
The incorporation of gamified features in learners' collaborative tasks improves communication among team members.	4.54	0.91	Strongly Agree
Gamification enhances team's motivation to actively participate in collaborative projects.	4.52	1.15	Strongly Agree
Collaborative tasks with gamified elements contribute to a more enjoyable and interactive teamwork experience.	4.78	1.04	Strongly Agree
The use of gamification in learners' collaborative efforts has a positive impact on overall team productivity.	4.57	1.21	Strongly Agree

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Weighted Mean	*4.61*
SD	*1.07*
Verbal Interpretation	*Very High*

The level of gamification in terms of collaboration attained a weighted mean score of 4.61 and a standard deviation of 1.07 and was verbally interpreted as *very high* among the respondents.

Level of Gamification in terms of Mechanics

Table 7 shows the level of gamification in terms of mechanics. It also shows the statements, mean, standard deviation, remarks and verbal interpretation.

Table 7. **Level of Gamification in terms of Mechanics**

STATEMENT	***MEAN***	***SD***	***REMARKS***
The game mechanics implemented in learners' gamified experiences are clear and easy to understand.	4.70	1.09	Strongly Agree
The rules and goals of the gamification elements are well-defined and contribute to a meaningful experience.	4.67	0.97	Strongly Agree
The feedback provided by the gamification mechanics is timely and helps in understanding progress or achievement.	4.63	1.04	Strongly Agree
The integration of game elements enhances the overall user experience in the activities.	4.55	0.99	Strongly Agree
The complexity of gamification mechanics aligns well with the nature of the tasks and goals in learners' context.	4.52	1.15	Strongly Agree
Weighted Mean	*4.61*		
SD	*1.05*		
Verbal Interpretation	*Very High*		

The level of gamification in terms of mechanics attained a weighted mean score of 4.61 and a standard deviation of 1.05 and was verbally interpreted as *very high* among the respondents.

The students agreed that the game mechanics implemented in learners' gamified experiences are clear and easy to understand (M = 4.70, SD = 1.09), the rules and goals of the gamification elements are well-define and contribute to a meaningful experience (M = 4.67, SD = 0.97), the feedback provided by the gamification mechanics is timely and helps in understanding progress or achievement (M = 4.63, SD = 1.04), the integration of game elements enhances the overall user experience in the activities (M = 4.55, SD = 0.99) and the complexity of gamification mechanics aligns well with the nature of the task and goals in learners' context (M = 4.52, SD = 1.15).

The mechanics of gamification activities are clear, easy to understand and implemented effectively as the goal and objective of the activities were met while the learners enjoyed throughout the learning process.

Level of Gamification in terms of Reward System

Table 8 shows the level of gamification in terms of reward system. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Table 8. **Level of Gamification in terms of Reward System**

STATEMENT	***MEAN***	***SD***	***REMARKS***
The rewards offered in gamified activities are motivating and meaningful.	4.88	1.03	Strongly Agree
The reward system effectively encourages participants to actively engage in gamified tasks.	4.63	1.04	Strongly Agree
The variety of rewards available in gamification approach caters to different preferences and interests.	4.64	1.05	Strongly Agree
Participants find the rewards obtained through gamification to be commensurate with their efforts and achievements.	4.66	1.10	Strongly Agree
The reward system in gamified experiences enhances the overall satisfaction of participants.	4.74	1.14	Strongly Agree
Weighted Mean	*4.71*		
SD	*1.08*		
Verbal Interpretation	*Very High*		

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The gamified activities are motivating and meaningful. The mean (M = 4.88 and SD = 1.03) suggests a *very high* level of gamification in terms of reward system. However, the students also agreed that the reward system effectively encourages participants to actively engage in gamified tasks. While the mean is slightly lower (M = 4.63 and SD = 1.04), it still indicates that the reward system is effective for the learners to be more active and encouraged to learn during gamification.

The level of gamification in terms of reward system attained a weighted mean score of 4.71 and a standard deviation of 1.08 and was verbally interpreted as *very high* among the respondents.

As a summary, the reward system during gamification is motivating and meaningful, it gives encourage the learners to be more active, the variety of rewards available in gamification approach caters to different preferences and interests, they find it as commensurate with their efforts and achievements, and also it enhances the overall satisfaction of participants.

Level of Gamification in terms of Content

Table 9 shows the level of gamification in terms of content. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

The students agreed that the gamified content in the activities is relevant and aligns well with the overall objectives. The mean (M = 4.69 and SD = 1.01) suggests a *very high* level of gamification in terms of content. However, the students also agreed that the integration of gamification elements enhances the clarity and understanding of the education or informational content. While the mean is slightly lower (M = 4.50 and SD = 1.01), it still indicates through the content of gamification, the clarity and understanding of the education or informational content are engaging and interesting.

Table 9. **Level of Gamification in terms of Content**

STATEMENT	***MEAN***	***SD***	***REMARKS***
The gamified content in the activities is relevant and aligns well with the overall objectives.	4.69	1.01	Strongly Agree
The integration of gamification elements enhances the clarity and understanding of the educational or informational content.	4.50	0.95	Strongly Agree
The gamification of content aids in better retention and comprehension of information.	4.52	0.99	Strongly Agree
Participants find the gamified content engaging and interesting.	4.64	0.99	Strongly Agree
The level of challenge presented by gamified content is appropriate and enhances the learning or interactive experience.	4.59	1.15	Strongly Agree
Weighted Mean	*4.59*		
SD	*1.02*		
Verbal Interpretation	*Very High*		

The level of gamification in terms of content attained a weighted mean score of 4.59 and a standard deviation of 1.02 and was verbally interpreted as very *high* among the respondents.

As a summary, the gamification in terms of content must be relevant and aligned with the overall objectives, elements enhance the clarity and understanding of the educational or informational content, it aids in better retention and comprehension of information, engaging, interesting, appropriate and enhances the learning or interactive experience.

Level of Gamification in terms of Feedback

Table 10 illustrates the level of gamification in terms of feedback. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Table 10. **Level of Gamification in terms of Feedback**

STATEMENT	***MEAN***	***SD***	***REMARKS***
The feedback provided in gamified experiences is clear and easily understandable.	4.72	1.04	Strongly Agree
The feedback received through gamification enhances learner's understanding of their performance.	4.70	1.04	Strongly Agree
The feedback system effectively motivates participants to improve their performance.	4.74	1.07	Strongly Agree
Participants find the feedback received in gamified tasks to be constructive and helpful.	4.75	1.07	Strongly Agree
The frequency of feedback in the gamified experiences is appropriate for the learning or task objectives.	4.77	1.05	Strongly Agree

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Weighted Mean	*4.74*
SD	*1.05*
Verbal Interpretation	*Very High*

Students agreed that the frequency of feedback in the gamified experiences is appropriate for the learning or task objectives. The mean (M = 4.77 and SD = 1.05) suggests a *very high* level of gamification in terms of feedback. However, the students also agreed that the feedback received through gamification enhances learner's understanding of their performance. While the mean is slightly lower (M = 4.70 and SD = 1.04), yet still indicates that gamification helps them to improve their academic performance.

The level of gamification in terms of feedback attained a weighted mean score of 4.74 and a standard deviation of 1.05 and was verbally interpreted as *very high* among the respondents.

As a summary, the feedback during gamification provided gamified experiences is clear and very understandable, received through gamification enhances learners' performance, motivates the learners to improve their performance, finds the feedback constructive and helpful, and frequency of feedback must be appropriate for the learning or task objectives.

Level of Numerical Intuition

Numerical intuition refers to our innate ability to perceive and work with numbers, often without conscious effort. These intuitive representations of the mental number line exist across species and human development. In this study, it explored the level of numerical intuition in terms of sense of numbers, relationships, and patterns particularly in learning mathematical concepts.

Furthermore, the results are represented through tables and interpreted the statistical aspects employing the mean, standard deviation, remarks, and verbal interpretation.

Level of Numerical Intuition in terms of Number Sense

Table 11 shows the level of learners' numerical intuition in terms of number sense. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Table 11. **Level of Numerical Intuition in terms of Number Sense**

STATEMENT	***MEAN***	***SD***	***REMARKS***
Numerical intuition enhances learners' understanding of numerical concepts related to Sense of Numbers.	4.81	0.98	Strongly Agree
Visual representations help learners develop a clearer mental image of numerical relationships.	4.63	1.02	Strongly Agree
Learners feel more confident in my numerical intuition when visual aids are incorporated into the learning materials.	4.60	1.07	Strongly Agree
Numerical information helps learners grasp abstract mathematical ideas related to Sense of Numbers.	4.61	1.06	Strongly Agree
The inclusion of numerical elements in learning activities positively impacts learners' overall sense of numbers.	4.51	1.14	Strongly Agree

Weighted Mean	*4.63*
SD	*1.06*
Verbal Interpretation	*Very High*

The table above shows the level of learner's numerical intuition in terms of number sense. The respondents strongly agreed that numerical intuition enhances learners' understanding of numerical concepts related to sense of numbers. The mean of 4.81 with standard deviation 0.98 suggests a *very high* level of learners' numerical intuition. They also strongly agreed that the inclusion of numerical elements in learning activities positively impacts learners' overall sense of numbers. Although the mean of 4.51 with standard deviation 1.14 is slightly lower than the former statement, it still suggests a very high level of numerical intuition.

The overall mean of 4.63 with standard deviation 1.06 indicates a *very high* level of learners' numerical intuition in terms of number sense. Thus, the respondents are very capable of understanding numerical concepts when visual aids were incorporated on their learning materials.

Level of Numerical Intuition in terms of Relationships

Table 12 shows the level of learners' numerical intuition in terms of relationships. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

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Table 12. **Level of Numerical Intuition in terms of Relationships**

STATEMENT	*MEAN*	*SD*	*REMARKS*
Numerical intuition enhances learners' understanding of numerical relationships.	4.74	0.98	Strongly Agree
Numerical representations help leaners see connections between different numerical concepts more clearly.	4.73	0.96	Strongly Agree
Learners feel more confident in recognizing and understanding relationships among numbers when visual aids are incorporated into learning materials.	4.68	1.03	Strongly Agree
Numerical information helps learners grasp the interconnectedness of various mathematical ideas related to Relationships.	4.54	0.97	Strongly Agree
The inclusion of numerical elements in learning activities positively impacts learners' overall understanding of numerical relationships.	4.56	1.13	Strongly Agree
Weighted Mean	*4.65*		
SD	*1.02*		
Verbal Interpretation	*Very High*		

The respondents strongly agreed that numerical intuition enhances learners' understanding of numerical relationships. The mean of 4.74 and standard deviation 0.98 suggests a *very high* level of learners' numerical intuition. They also strongly agreed that the inclusion of numerical information helps learners grasp the interconnectedness of various mathematical ideas related to relationships. The mean of 4.54 and standard deviation 0.97 is slightly lower than the former statement and still suggests a *very high* level of learners' numerical intuition.

The overall mean 4.65 with standard deviation 1.02 suggests a *very high* level of numerical intuition in terms relationship. This means that the respondents are highly confident to distinguish numerical relationship and connections.

Level of Numerical Intuition in terms of Patterns

Table 13 shows the level of learners' numerical intuition in terms of patterns. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Respondents strongly agreed that numerical intuition enhances learners' understanding of numerical patterns. The mean of 4.74 and standard deviation 1.04 suggest a *very high* level of numerical intuition in terms of patterns. The respondents also strongly agreed that inclusion of numerical elements in learning activities positively impacts learners' overall ability to understand and work with numerical patterns. The mean of 4.59 and standard deviation 1.04 is slightly lower than the previous statement, this still suggests a *very high* level of numerical intuition.

Table 13. **Level of Numerical Intuition in terms of Patterns**

STATEMENT	*MEAN*	*SD*	*REMARKS*
Numerical intuition enhances learners' understanding of numerical patterns.	4.74	1.04	Strongly Agree
Numerical representations help leaners identify and analyze patterns in numerical sequences more effectively.	4.67	1.00	Strongly Agree
Learners feel more confident in recognizing and predicting patterns when visual aids are incorporated into learning materials.	4.64	0.97	Strongly Agree
Numerical information helps learners grasp the underlying patterns and structures in mathematical concepts related to Patterns.	4.62	1.02	Strongly Agree
The inclusion of numerical elements in learning activities positively impacts learners' overall ability to understand and work with numerical patterns.	4.59	1.04	Strongly Agree
Weighted Mean	*4.65*		
SD	*1.02*		
Verbal Interpretation	*Very High*		

The overall mean of 4.65 with standard deviation 1.02 suggests a *very high* level of learners' numerical intuition in terms of patterns. This means that the respondents are highly confident to recognize and analyze numerical patterns.

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 9| September 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

Level of Numerical Reasoning

Numerical reasoning is a fundamental cognitive process that allows us to make sense of quantitative information, draw inferences, and arrive at logical conclusions. It integrates logical inference, analogical thinking, and decision-making. By leveraging these cognitive processes, one can enhance our problem-solving abilities and adapt effectively to various situations.

Furthermore, the following tables are presented and interpreted the statistical aspects through mean, standard deviation, remarks, and verbal interpretation.

Level of Numerical Reasoning in terms of Logical Inference

Table 14 shows the level of learners' numerical reasoning in terms of logical inference. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Table 14. **Level of Numerical Reasoning in terms of Logical Inference**

STATEMENT	***MEAN***	***SD***	***REMARKS***
Numerical reasoning enhances learners' ability to make logical inferences based on numerical information.	4.77	1.05	Strongly Agree
Numerical reasoning help leaners draw accurate conclusions and make logical deductions when presented with numerical data.	4.66	1.04	Strongly Agree
Learners feel more confident in applying logical reasoning to numerical problems when visual aids are incorporated into learning materials.	4.61	1.09	Strongly Agree
Numerical reasoning helps learners develop a more systematic approach to logical inference in mathematical contexts.	4.62	1.04	Strongly Agree
The inclusion of numerical elements in learning activities positively impacts learners' overall ability to engage in logical inference with numerical reasoning.	4.49	1.18	Strongly Agree
Weighted Mean	*4.63*		
SD	*1.09*		
Verbal Interpretation	*Very High*		

Respondents strongly agree that numerical reasoning improves their competence with the mean of 4.77 and standard deviation 1.05 implies a *very high* level of skill to make logical inferences based on numerical information. The respondents also strongly agreed that inclusion of numerical elements in learning activities positively impacts learners' overall ability to engage in logical inference with numerical reasoning with the mean of 4.49 and standard deviation 1.18, even though it is slightly lower than the previous statement, this still suggests a *very high* level of numerical reasoning.

Level of Numerical Reasoning in terms of Analogical

Table 15 shows the level of learners' numerical reasoning in terms of analogical. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Table 15. **Level of Numerical Reasoning in terms of Analogical**

STATEMENT	***MEAN***	***SD***	***REMARKS***
Numerical reasoning enhances learners' ability to draw analogies between numerical concepts.	4.67	1.02	Strongly Agree
Numerical reasoning help leaners see similarities and relationships among different numerical scenarios more clearly.	4.60	0.97	Strongly Agree
Learners feel more confident in applying analogical reasoning to numerical problems when visual aids are incorporated into learning materials.	4.55	1.06	Strongly Agree
Numerical reasoning helps learners develop a more intuitive sense of analogous situations in mathematical contexts.	4.48	1.11	Strongly Agree
The inclusion of numerical elements in learning activities positively impacts learners' overall ability to engage in analogical reasoning with numerical information.	4.48	1.17	Strongly Agree
Weighted Mean	*4.56*		
SD	*1.07*		
Verbal Interpretation	*Very High*		

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 9| September 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

Students believed that reasoning enhances learners' ability to draw analogies between numerical concepts. The mean (M = 4.67 and SD = 1.02) suggests a *very high* level of numerical reasoning in terms of analogical. However, reasoning helps learners develop a more intuitive sense of analogous situations in mathematical contexts and inclusion of numerical elements in learning activities positively impacts learners' overall ability to engage in analogical reasoning with numerical information. While the mean is slightly lower (M = 4.48 and SD = 1.17), it still indicates a *very high* numerical reasoning level with the use of analogical. The level of numerical reasoning in terms of analogical attained a weighted mean score of 4.56 and a standard deviation of 1.07 and was verbally interpreted as a *very high* among the respondents.

Level of Numerical Reasoning in terms of Decision-making

Table 16 shows the level of learners' numerical reasoning in terms of decision-making. It also shows the statements, mean, standard deviation, remarks, and verbal interpretation.

Students affirmed that reasoning enhances learners' ability to make informed decisions based on numerical information. The mean (M = 4.80 and SD = 1.01) suggests a *very high* level of numerical reasoning in terms of decision making. However, the inclusion of numerical elements in learning activities positively impacts learners' overall ability to make sound decisions with numerical reasoning. While the mean is slightly lower (M = 4.54 and SD = 1.17), it still indicates a *very high* numerical reasoning level with the use of decision making. The level of numerical reasoning in terms of decision making attained a weighted mean score of 4.66 and a standard deviation of 1.03 and was verbally interpreted as *very high* among the respondents.

Table 16. **Level of Numerical Reasoning in terms of Decision Making**

STATEMENT	***MEAN***	***SD***	***REMARKS***
Numerical reasoning enhances learners' ability to make informed decisions based on numerical information.	4.80	1.01	Strongly Agree
Numerical reasoning help leaners evaluate numerical options and alternatives more effectively in decision-making scenarios.	4.67	0.94	Strongly Agree
Learners feel more confident in utilizing numerical data to make decisions when visual aids are incorporated into learning materials.	4.62	1.00	Strongly Agree
Numerical reasoning helps learners develop a more systematic approach to decision-making in mathematical contexts.	4.65	1.01	Strongly Agree
The inclusion of numerical elements in learning activities positively impacts learners' overall ability to make sound decisions with numerical reasoning.	4.54	1.17	Strongly Agree
Weighted Mean	*4.66*		
SD	*1.03*		
Verbal Interpretation	*Very High*		

As a summary, learners emphasized the importance of numerical reasoning in evaluating options, feeling more confident in using numerical data for decision-making, and developing a systematic approach.

Studies have explored the role of numerical literacy in health decision-making, particularly in understanding risk information and making informed healthcare choices.

4. CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, the following conclusions were drawn:

The implication of visualization and gamification on numerical intuition and numerical reasoning was observed to have a relationship.

The visualization and gamification techniques may likely collaborate to stimulate various cognitive functions related to numerical processing, leading to improved numerical intuition and reasoning skills. This indicates that other factors might be at play in developing these critical mathematical skills, such as the quality of instruction, the inherent abilities of the students, or the specific design and implementation of the visual and gamified elements used in the study.

Based on the conclusions, resulted in the following recommendations:

1. Teachers may continue to include visualization and gamification in the learners' activities to keep them motivated and increase their academic performance. They can participate and enjoy the lessons while understanding the topic clearly.
2. Schools may develop curricula that can fit the students' interests and abilities. They may also provide interactive activities and programs that can encourage the students to participate and keep them motivated.

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EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 9| September 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

3. Future researchers may use this study to serve as motivation and to inspire them in writing a research paper that will benefit their generations as well as the next one.

REFERENCE

1. *Öztürk, M., Akkan, Y., & Kaplan, A. (2020). Reading comprehension, Mathematics self-efficacy perception, and Mathematics attitude as correlates of students' non-routine Mathematics problem-solving skills in Turkey. International Journal of Mathematical Education in Science and Technology, 51(7), 1042–1058. https://doi.org/10.1080/0020739X.2019.1648893*