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Gamification Trend in Students' Mathematics Learning Through Systematic Literature Review

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Abstract
The gamification approach has the potential to improve learning performance and motivate students to study mathematics. Unfortunately, there is not much further discussion regarding gamification in a systematic mathematical context. This study is aimed at identifying the frequency of gamification studies in math education based on current year trends; the tendency of the country to apply gamification studies; identifying groups of respondents according to the level of study; and identifying the impact of gamification approaches on students' learning in terms of affective, cognitive, and psychomotor. A total of 21 empirical studies were selected from the systematic literature based on the Preferred Reporting Items for the Systematic Reviews and Meta-Analyses (PRISMA) model. This model involves four phases, namely identification, filtering, qualification (eligibility), and entry (included), using key databases such as Web of Science, Scopus, and ERIC. The findings show that gamification studies in math education set the most records in 2021. The trend of national analysis reports that the study of gamification in mathematics education is most studied in the country of Spain. Moreover, the most dominant sample of this research involves elementary school students. This study also reported the impact of gamification focused on both affective and cognitive aspects. The findings of the study have the potential to better measure the impact of gamification from other aspects and are given reference to the Ministry of Education (MOE), schools and teachers, especially in the mathematical context. These findings can be expanded by focusing on the impact of gamification in terms of psychomotor domains as well as diversifying different groups of respondents.
Keywords: Gamification, Systematic Literature Review, Mathematics Education, Learning, Students

Introduction

In this era of globalization, various countries are changing the current education system, as this system is the mainstay of the nation's development. Most of the lectures were conducted online due to the COVID-19 pandemic (Saifudin & Hamzah, 2021). However, the problem of students

getting bored and losing focus during learning needs to be addressed (Hilmi & Mohd. Shafiai, 2022), so that students do not drop out of learning. To bridge the education gap, the Ministry of Education Malaysia (MOE) has provided various digital platforms, especially EduwebTV and CikgooTube, throughout the implementation of home teaching and learning (PdPR). Students were found to be positive and more proficient in the knowledge of abstract mathematical concepts with the help of digital technology (Sintian et al., 2021; Putrawangsa & Hasanah, 2018). Gamification is considered a modern and technological approach that is believed to be very effective in delivering high-quality lessons. Gamification in education is one of the teachings and learning approaches with the aim of increasing student engagement and making teaching and learning sessions more interesting (Nisa et al., 2020). The main purpose of the implementation of gamification in education is to improve specific mathematical skills, create effective teaching and learning sessions, encourage proactive pupil engagement, and support changes in pupil behaviour. However, the implementation of gamification techniques is less appropriate to be carried out on pupils with special needs (Rosly & Khalid, 2017). This is due to the fact that the competence level of the pupil will affect the effectiveness of the implementation of gamification. In a general sense, this study was conducted to investigate the effectiveness of gamification in the field of mathematics as well as the appropriateness of this approach to pupils of multiple intelligences.

Based on these justifications, it is clear that the development of past studies lacks gamification in the subject of mathematics systematically. Information from the literature study highlights will help many when applying gamification in their teaching of mathematics as well as empower the skills of students. Therefore, this study aims to conduct a systematic literature review on gamification in mathematics education in the last five years from 2018 to 2022. This is to identify national trends, groups of respondents, and the current impact of gamification techniques in mathematics subjects in affective, cognitive, and psychomotor terms. In this study, only empirical studies from databases such as Web of Science, Scopus, and ERIC were selected.

Research Objective

A total of four objectives were outlined in this study, namely:

a) To identify the frequency of study of gamification approaches in mathematical education based on current year trends.

b) To identify the countries that are most likely to use gamification studies in math education.

c) To identify the respondent group based on the most prevalent level of study for gamification studies in mathematics education.

d) To determine the affective, cognitive and psychomotor impact of gamification approaches in mathematics subjects.

Definition

In general, a gamification is an approach that combines game design with the process of teaching and learning to stimulate the skills of students while encouraging interaction (Destiny, 2017). Thus, the gamification approach is also explained as motivating the actions and problem-solving skills of pupils (Kristanto, 2020). This will indirectly create a sense of learning inquiry in the students.

There are three main elements in gamification, namely the MDA model (mechanics, dynamics, and aesthetics). The MDA model is described as a game created to help one comprehensively research the design and game elements (Kusuma et al., 2018). This approach is divided into three sections representing different elements of the game to conduct a holistic analysis (Kim & Lee, 2015). In the MDA model, mechanics contain game rules that involve algorithms, game structures, and what players do themselves (Putra & Yasin, 2021). Moreover, dynamic means an outcome that can be observed through the process of production from mechanics. Aesthetics refers to the design of the game as well as the experience and interaction of the players during the activity.

Definition

Gamification is not a new idea. Since 2010, gamification has become a viable trend as society begins to believe in its potential to foster motivation, behaviour change, friendly competition, and collaboration in various contexts, such as customer engagement, employee performance, and social loyalty. Like other new technologies, gamification has been used in various domains such as marketing, healthcare, and so on. Gamification is a multidisciplinary concept that includes a range of theoretical and empirical knowledge, domains, and technological platforms and is driven by a variety of practical motivations (Seaborn & Fels, 2015). With this in mind, the term gamification has been defined as the use of game design elements in a non-game context (Deterding et al., 2011), the phenomenon of creating a fun experience (Hamari et al., 2014), or the process of making activities more fun like games (Werbach, 2014). Various studies have begun to examine and review the effectiveness of the behaviour and experience of students who learn through gamification approaches.

Since its emergence, gamification has sparked controversy between game designers, user experience designers, game theorists, and researchers in human-computer interaction (Mahnič, 2014). The effect on motivation or engagement was lower than expected (Broer, 2014). Despite this, great efforts have been made to take advantage of the motivation that comes from the gamification approach. One key sector that is being actively explored and which can motivate pupils is education. Motivation is an important predictor of student's academic achievement (Dichev & Dicheva, 2017). Gamification in education refers to the introduction of game elements and gaming experiences into the learning process. It has been adopted to support learning in order to address the attitudes, activities, and behaviours of pupils (Caponetto et al., 2014). Thus, this can state that the integration of game mechanics into the learning process can trigger a productive student learning experience (Hamari et al., 2014).

Research Methodology

To support the arguments against the findings from gamification studies in previous mathematics education, this study was conducted by leveraging the concept of systematic literature studies (SLR). Using systematic and specific methods, we can identify, select, and collect the relevant study data directly by referring to the questions of the studies that have

been presented. The methodology of this study is the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) model.

The process of reviewing the findings of this study consists of the following steps, such as (i) Determination of the study question; (ii) Search for articles on authentic websites; (iii) Designation of Entry/Exemption Criteria; (iv) Selection of Studies; (v) Data analysis and extraction; (vi) Summary and interpretation of findings; and (vii) Writing of revision reports.

The general review of this systematic review is carried out smoothly and easily through the process of searching for articles and journals in various specialized electronic databases and websites. To enhance the credibility and integrity of this study, articles found in the web of article searches such as Web of Science, Scopus, and ERIC alone are used as references. Google Scholar and other websites were not selected because they could not verify the validity of the findings and had articles published outside of educational journals. Articles that are not relevant to the field of education are also ignored because the study focuses only on the field of education.

Gamification is often associated with or referred to in different terms. For example, gamified applications, gamified environments, gamification, and game-based applications refer to the gamification approach (Jusuf, 2016). Based on past studies, in order to maximize the amount of information that can be obtained in the SLR, it is important to diversify the specific terms of gamification that carry an equivalent meaning. Therefore, alternative keywords have been identified through the database and applied in different combinations. The keywords used during the article searching process include basic terms related to the topic of study as well as information related to the question of this study, such as "gamification", "Mathematical subject", "game element", "educational level" as well as other keywords as listed in Table 1.

Table 1
Keywords for the search strings

No.	Database	Keywords
1.	ERIC	gamification AND mathematic*
2.	SCOPUS	(TITLE-ABS-KEY(("impact*" OR "effectiveness*" OR "effect*" OR "motivation*" OR "engagement*" OR "participation*" OR "self-efficacy*" OR "satisfaction" OR "behaviour*" OR "attitude*" OR "thinking" OR "critical thinking" OR "cognition" OR "cognitive") AND ("gamification in education" OR "gamification of learning" OR "gamification of math*" OR "gamification in mobile app*" OR "gamification and math*" OR "educational game*" OR "game design*" OR "game element*" OR "game like element*" OR "game feature*" OR "non-game element*" OR "gamifying learning" OR "gamified element*" OR "game mechanic*" OR "non-game context*" OR "gamification*" OR "gamify*" OR "gamify learning experience" OR "gameplay element*" OR "gamification mechanic*" OR "gamified mobile app*" OR "gamified elearning" OR "gaming technique*" OR "gamified software" OR "gamification software" OR "gamification in

		learning" OR "gamified assessment" OR "gamifying learning experience" OR ("gamification" "eLearning") OR "game structure*" OR "gamified learning platform" OR "gamified tool*" OR "gamification app*" OR "game play" OR "gamification feature*" OR "gamified learning") AND ("in mathematic*" OR "education in math*" OR "teaching and learning in math*" OR "pedagogy in math*" OR "learning mathematic*" OR "math* classroom" OR "math*" OR "math* education" OR "gamify math*") AND ("student*" OR "learner*" OR "pupil*" OR "child*" OR "school") AND NOT ("engineering" OR "finance" OR "programming") AND NOT "geogebra"))
3.	Web Of Science	TS=((“impact*” OR “effectiveness*” OR “effect*” OR “motivation*” OR “engagement*” OR “participation*” OR “self-efficacy*” OR "satisfaction" OR “behaviour*” OR “behavior*” OR “attitude*” OR “thinking” OR “cognitive” OR “critical thinking”) AND ("gamification in education" OR "gamification of learning" OR "gamification of math*" OR "gamification in mobile app*" OR "gamification and math*" OR "educational game*" OR "game design*" OR "game element*" OR "game like element*" OR "game feature*" OR "non-game element*" OR "gamifying learning" OR "gamified element*" OR "game mechanic*" OR "non-game context*" OR "gamification*" OR "gamify*" OR "gamify learning experience" OR "gameplay element*" OR "gamification mechanic*" OR "gamified mobile app*" OR "gamified elearning" OR "gaming technique*" OR "gamified software" OR "gamification software" OR "gamification in learning" OR "gamified assessment" OR "gamifying learning experience" OR ("gamification eLearning") OR "game structure*" OR "gamified learning platform" OR “gamified learning” OR "gamified tool*" OR "gamification app*" OR "gamification in education" OR "game play" OR "gamification feature*") AND ("in mathematic*" OR "education in math*" OR "teaching and learning math*" OR "pedagogy in math*" OR "learning math*" OR "math* classroom" OR "math*" OR "math* education" OR "gamify math*") AND ("student*" OR "learner*" OR "pupil*" OR "child*" OR "school") NOT ("engineering" OR "finance" OR "programming") NOT "geogebra")

Inclusion/Exclusion Criteria

To ensure the authenticity of the information in this study, the researchers set out and listed specific criteria for filtering the study, selecting and engaging information related to the topic of this study, as well as interpreting the appropriateness of the articles obtained. Less suitable

articles are isolated because they do not meet some of the pre-determined requirements. Table 2 shows the criteria for the inclusion and exclusion of articles.

Table 2
Article inclusion and exclusion criteria

No.	Inclusion Criteria Details	Exclusion Criteria Details
1.	Studies relate to gamification in the subject of mathematics.	Studies conducted in languages other than English.
2.	The practice of gamification was examined in studies containing at least one game element in the MDA model. Gamification practice must be applied and leveraged in teaching and learning sessions, and it should be supported with empirical data	Studies related to information other than gamification approaches, such as game-based learning and video-based learning.
3.	Studies from all over the country.	Studies show a lack of authenticity in the information.
4.	Studies that have empirical data (quantitative, qualitative, quasi-experimental, or mixed methods) in the process of teaching and learning.	The studies were listed in databases other than ERIC, Scopus and Web Of Science.
5.	Published articles from 2018 to 2022. To combine gamification with high-tech tools, researchers only examined studies published in the last five years, specifically after the pandemic era.	Studies that do not associate elements of the game with the learning process.

Review Process

Due to the large data search from the database, the literature review is written based on two additional criteria which are the time period and the rationale of the research. A total of 21 results were obtained from all three databases which are considered in this review process as per required by the research. As per listed in Table 3, all initial findings of all the databases resulted in 756 articles. However, 665 articles were removed based on the publication dates, title reviews, relevancy, and abstract review. Then, a total of 19 articles were eliminated from a total of 110 initial articles due to the redundancy found. A balance of 91 articles was used to collect more data for the research. Besides that, a total of 70 research papers does not suit the mathematical theme were eliminated from the list of articles. Only 21 articles were reviewed in order to determine the suitability of the articles based on their criteria and the assigned research topic. The thematic analysis was used throughout the review process. All research papers took similar initiatives in order to review and revise all the articles multiple times in order to ensure that all research papers adhere to the content, procedure, methods used and the research findings presented. Lastly, all the data collected are compared and discussed in this research. This systematic research revised a total of 21 writing publications which are listed as the final data collection (Table 4). Figure 1 shows the PRISMA process which was conducted in this research.

Table 3
Source of article collection

Database	Identification	Screening	Eligibility	Inclusion	Selection
ERIC	442	395	47	33	6
SCOPUS	22	356	46	47	9
Web of Science (WOS)	402	5	17	11	6
Total	866	756	110	91	21

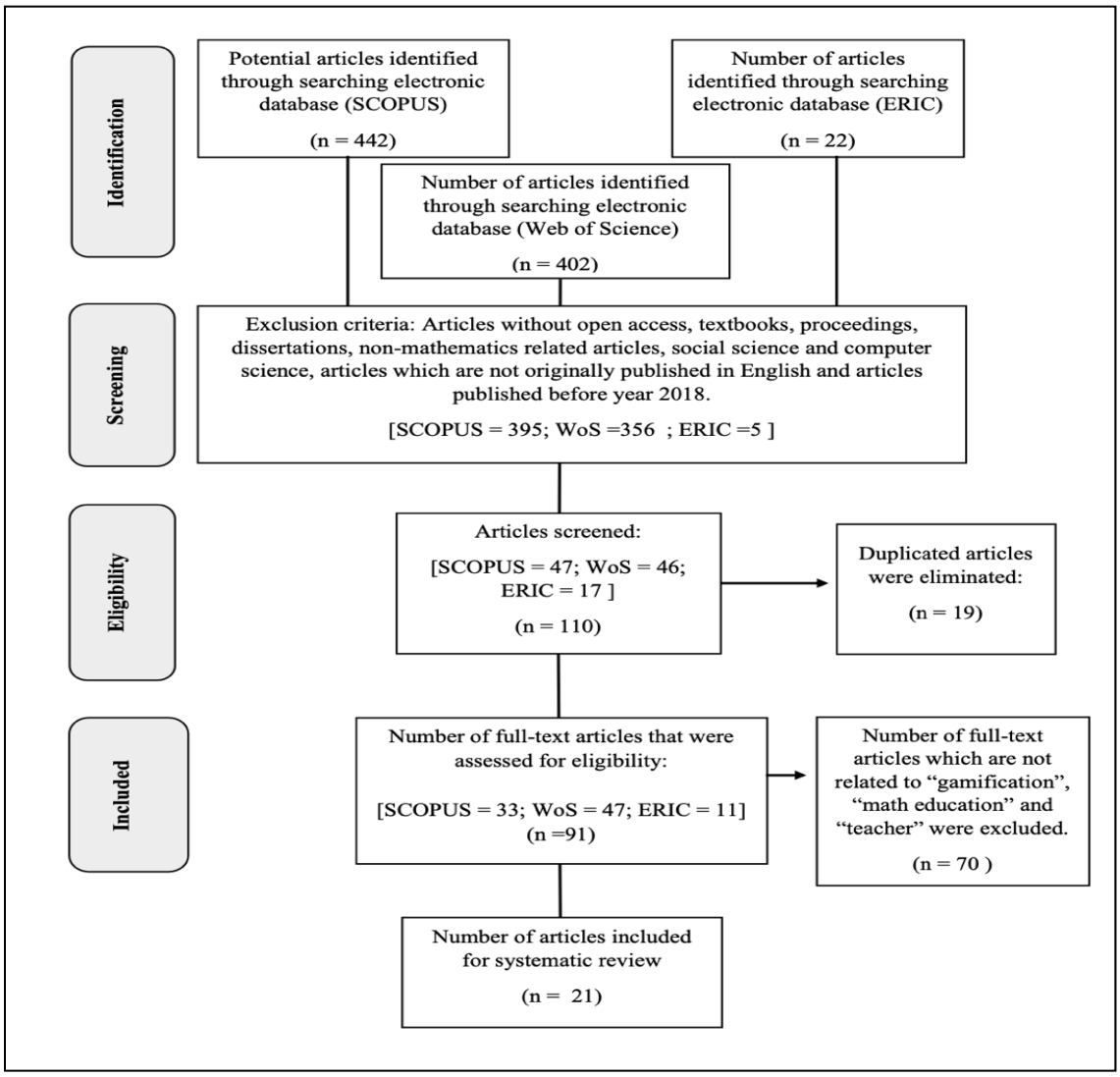

Figure 1. Flow diagram of the study using PRISMA.

Table 4
Generalisation distribution of the 21 empirical studies.

Title, Writer, Year of Publication, Country	Mathematical Topics Involved	Respondent	Engaged Learning Domains (Affective/Cognitive / Psychomotor)	Impact	Findings
An experimental study on the effects of a gamified software intervention in mathematics achievement among sixth grade students Watson (2018) Jamaica	Numbers, measurements, geometry, statistics, algebra and probability	1. 95 students in Grade 1, 129 students in Grade 2 2. 167 Grade 3 students 3. 147 Grade 4 students 4. 126 Grade 5 students 5. 145 Grade 6 students	1. Affective 2. Cognitive	Motivation, engagement, learning and learning attitudes	1. Gamification does not improve student performance. 2. Students of the treatment group behave positively towards mathematics.
The effectiveness of gamification in learning indices and logarithm Ahmad et al (2018) Malaysia	Index and logarithm	100 diploma students	1. Affective 2. Cognitive	Learning satisfaction and learning performance	1. The gamification element has developed students' interest in learning in an interesting and fun way. 2. Gamification has a significant impact on improving student performance on index and logarithmic topics. 3. Students respond well to new learning methods.

Evaluation of an educational media on cube nets based on learning effectiveness and gamification parameters Wardani et al (2019) Indonesia	Geometry	28 elementary students	1. Cognitive 2. Affective	Motivation, behaviour and psychology	1. The student's learning performance increases after using the developed educational media. 2. Motivational scoring from the questionnaire showed a score of 87.14%, while psychology was 91.67% and behaviour was 90.57%.
A research of gamification impact in learning mathematics Abidin et al (2019) Malaysia	Index and logarithm	140 diploma students	1. Cognitive 2. Affective	Performance and emotions of learning	1. Gamification motivates students in a self-learning environment to have fun learning and improve their critical thinking.
From here to there! Elementary: A game-based approach to developing number sense and early algebraic understanding	Algebra	185 students from Grade 2	1. Cognitive 2. Affective	Motivation, engagement, learning and learning experience	1. Studies show that when students play the gamified version of the game app, they achieve higher levels of learning than those that play gaming apps without the gamification version. 2. Students who achieve higher in their learning solve more

Hulse et al (2019) United States					problems in post-tests. 3. Two significant interactions were found between progress and existing knowledge, as well as the involvement in problem-solving and existing knowledge, where low-performing students gain more as they solve more problems.
JeuTICE: An Arabic serious game to enhance mathematics skills of young children Tazouti et al (2019) Morocco	Numbers, geometrics and measurements	60 students from Grade 5 and 6	1. Affective 2. Cognitive	Motivation, experience of use of gamification tools, mathematical skills	1. JEUTICE increases students' interest in math learning. 2. There is room for improvement in terms of self-confidence, thinking ability, mastery of basic mathematical skills and computing skills.

Mathematics trails: Shallow and deep gamification Gurjanow et al (2019) Germany	Statistics	218 students from Grade 9	1. Affective	Motivation and learning performance	1. The introduction of gamification elements had a small improvement in learning motivation but managed to influence the parameters of learning performance through questionnaires. 2. In particular, the gamification of the leader board increases the speed of question solving and reduces the probability of wrong answers.
Using web-based gamified software to learn Boolean algebra simplification in a blended learning setting Jiménez-Hernández et al (2020) Mexico	Algebra	University students (Unknown number)	1. Affective 2. Cognitive	Motivation, learning performance, learning engagement	1. Gamification tools increase student motivation through the use of rankings that indicate the level of student participation. 2. The statistical results obtained show that the use of MiniBool has a positive effect on higher learning motivation and academic performance compared to traditional teaching-learning methods.

Effects of a successful mathematics classroom framework on students' mathematics self-efficacy, motivation and achievement: a case study with freshmen students at a university foundation programme in Kuwait Hammad et al (2020) Kuwait	Algebra	130 new students at the university	1. Cognitive 2. Affective	Self-efficacy, motivation and learning performance	1. The implementation of the SMC framework helps to develop self-efficacy and motivation to learn, thus improving learning performance in mathematics. 2. The most significant impact aspects include teaching methodology, group work, teacher attitude, and gamification.
The effect of gamification on young mathematics learners' achievements and attitudes Karamert & Vardar (2020)	Fraction	46 students from Grade 5	1. Cognitive 2. Affective	Learning performance and learning attitudes	1. The test scores of the experimental group's achievements were higher than those of the control group. 2. Gamification is ineffective in changing attitudes towards learning mathematics.

Turkey					
Learning Mathematics with emerging methodologies—The escape room as a case study Fuentes-Cabrera et al (2020) Spain	Algebra, logics dan geometry	62 high school students	1. Cognitive 2. Affective	Learning performance, motivation, and autonomy	1. Experiences developed through the '*Escape Room'* include learning performance, motivation, and autonomy. 2. The use of the 'Escape Room' in mathematics improves learning performance, motivation, and autonomy.
Children building and having fun while they learn geometry Puig et al (2021) Spain	Geometry	60 primary or secondary school students	1. Cognitive 2. Affective	Motivation, engagement, satisfaction and learning performance	1. Gamification activities provide motivation, stimulate engagement and improve students' mathematics learning performance.
Formation of computational thinking skills using computer games in teaching mathematics	Application of mathematical problems, problem solving	26 students from Grade 5 and 6	1. Cognitive	Computational thinking	1. Gamification activities develop a gaming educational space with mathematical content and digital gamification resources that have contributed to the development of computational thinking.

Soboleva et al (2021) Russia					
Enhancing statistical literacy skills through real life activities enriched with gamification elements: An experimental study Cakiroglu & Guler (2021) Turkey	Statistics	41 students from Grade 7	1. Affective	Motivation and learning engagement	1. The teaching process using gamification tools supports students towards phased learning objectives. 2. The gamification elements used in the classroom have developed their involvement not only in the school but also outside. 3. Students in gamification classes perform better than students in non-gamification groups.
Serious games and mathematical fluency: A study from the gender perspective in primary education Fraga-Varela et al (2021)	Combined operations of addition, subtraction, multiplication and division	284 students from Grade 1 to 4	1. Cognitive	Learning performance	1. Both gender groups, male and female, increase in terms of their academic performance after playing serious games. 2. Male academic performance is superior to female academic performance.

Spain					
The impact of serious games in mathematics fluency: A study in primary education Fraga-Varela et al (2021) Spain	Calculus	284 primary school students	1. Affective 2. Cognitive	Motivation and learning performance	1. Studies show increased significance in mathematical fluency with the use of serious games in different grades and groups of studied classrooms. 2. The gamification strategy promotes greater progress on classes that have not yet been implemented. 3. It also shows the relationship between the results obtained and the grades of schoolchildren. 4. The use of serious games designed specifically for the school environment challenges teachers.

Escape room dual mode approach to teach maths during the COVID-19 era Rosillo & Montes (2021) Spain	Statistics	106 university students	1. Affective 2. Cognitive	Learning performance	1. The use of '*Escape Room'* in mathematics subjects has contributed to an increase in the different concepts studied, such as subject perception and motivation and interaction among students who are not in the same classroom physically. 2. This resource has also proven to be effective in improving the performance of online learning.
Effectiveness of gamification in teaching and learning mathematics Ariffin et al (2022) Malaysia	Statistics and probabilities	111 diploma students	1. Affective 2. Cognitive	Learning attitude (experience, satisfaction, motivation) and learning performance	1. The results show a significant relationship between all these factors and the student's assessment score. 2. An increase in the motivation of students to learn and participate in class activities contributes to their performance in the subjects taught. 3. Gamification integration improves cognitive, emotional, social learning and cooperative learning skills. It also helps students increase their interest in mathematics and encourages them to learn better.

Gamification as a Teaching Method to Improve Performance and Motivation in Tertiary Education during COVID-19: A Research Study from Mexico Rincon-Flores et al (2022) Mexico	Calculus	78 university students	1. Affective 2. Cognitive	Grades, motivation, quality of coursework, learning, and emotional engagement	1. There is a stronger positive relationship among variables among engineering undergraduate students compared to undergraduate students of economics and social Sciences. 2. Emotions are less correlated with performance, especially for students of economics and social sciences, since many have a negative attitude towards learning mathematics. 3. Gamification has proven to be a useful pedagogical strategy to encourage learning engagement and increase motivation among students, although it does not seem to improve their learning performance. 4. Gender does not affect motivation either in performance nor in motivation, and emotions.

The impact of game elements on learner motivation: Influence of initial motivation and player profile Reyssier et al (2022) France	Algebra	256 secondary school students	1. Affective	Learning motivation and player profile	1. Randomly assigned gamification game elements weaken the student's morale. A more thorough analysis reveals that gamification has a positive effect on students who are most motivated to study mathematics, although different effects are observed on students. 2. Significant influence was seen on the initial level of motivation and the type of player on the motivational variation during the study. 3. These influences vary according to the elements of the game used by the students.

Research Findings

Findings of the First Research Objective

To identify the frequency of the gamification trends in Mathematics learning based on current year trends

The literature review of this research has set a restriction to only consider articles published in the year 2018 until year 2022. Figure 2 shows the number of articles published based on the publication year. It was found that only 2 out of 21 research papers were published in the year 2018. In the recurrent year, the total of articles published increased to a total of 3 papers. Only 4 articles were published in the year 2020. The threats of the Covid-19 pandemic have caused a sudden shift from face-to-face learning to online learning. Besides that, the research on gamification in Mathematics learning started to become popular with a total of 7 publications in the year 2021 with the highest record. Lastly, only 3 publications were recorded in the database throughout this year.

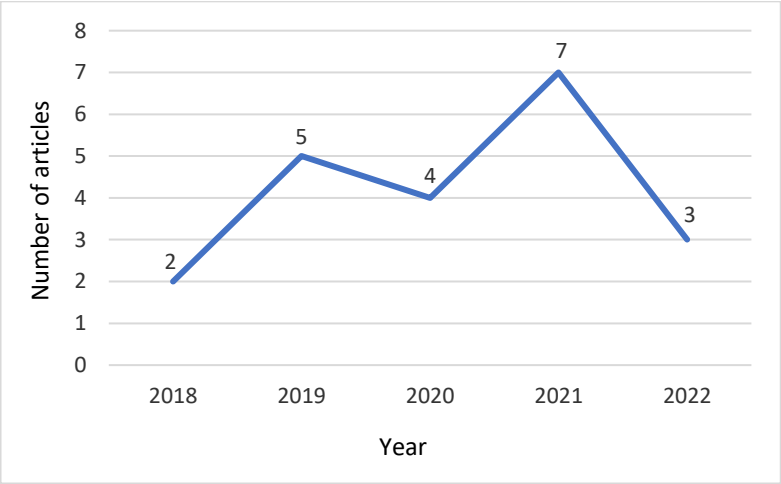

Figure 2. Total number of articles published between 2018 and 2022

Findings of the second research objective

to identify the country which is prone to apply gamification in mathematics learning

The systematic literature shows that Spain is the country which is prone to apply gamification in Mathematics learning with a total of 5 publications published. Malaysia is the second country with the most publication with a total of 3 articles. Besides that, two countries which are Mexico and Turkey have both published a total of 2 articles on the research topic. Other countries such as the United States of America, Indonesia, Jamaica, German, Kuwait, Morocco, France, Russia, and Taiwan have all published only one research on the research topic. It was revised that all research locations conducted often differ from the location of the research being written and published.

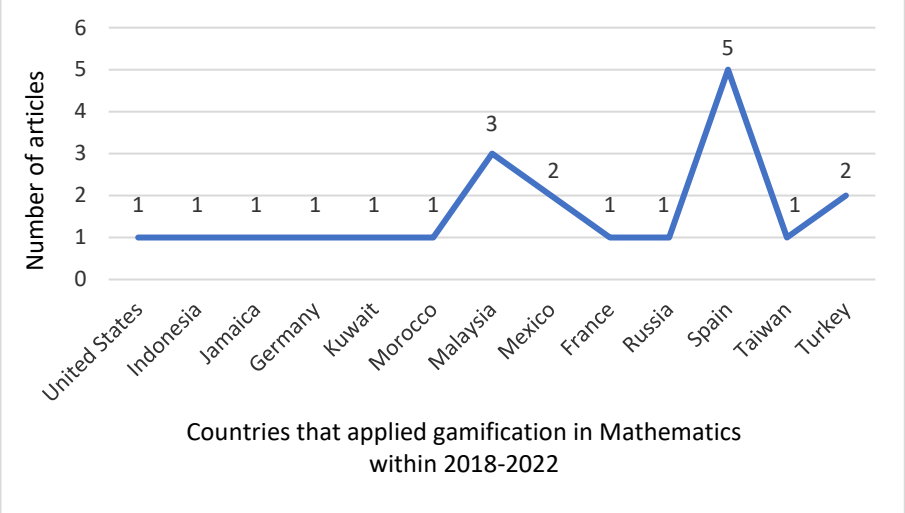

Figure 3. Total number of articles published based on countries

Findings of the Third Research Objective

To identify respondent groups based on education level for gamification in Mathematics learning

In identifying respondent groups based on education level for research papers in gamification in Mathematics learning, there are 8 out of 21 research papers chose primary school students as research samples. Most primary students are from Level 2 (year 4 to 6) even though there is a small number of research that involves pupils from Level 1. Besides that, there are 7 out of 21 research papers that involve secondary students and most of these students are from Grade 7 to Grade 9. Tertiary-level students are also used in a total of 6 research papers. Some of these tertiary-level students are either from diploma courses or from the first semester of their degree program. Based on the courses chosen, most of the tertiary-level students are from pure science courses such as Nursing and Engineering. However, there are also researchers that study the issue based on tertiary-level students who are not from pure science courses.

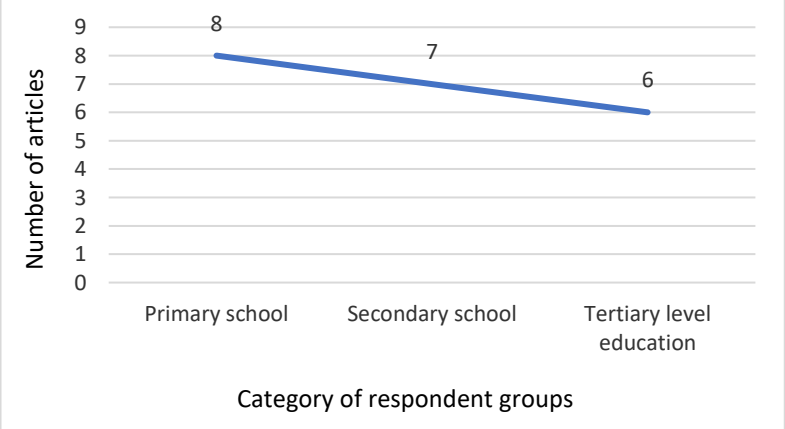

Figure 4. Number of articles published based on the 3 groups of respondents.

Findings of The Fourth Research Objective

To identify the impact gamification on the subject of Mathematics in the aspects of affective, cognitive and psychomotor

The findings show that the impact of the trends of gamification on Mathematics subject can be divided into three aspects which are affective, cognitive, and psychomotor. Most of the research papers (16 articles) have reported the impact from both affective and cognitive aspects. Figure 5 shows the impact of gamification on the Mathematics subject from the aspect of affective, cognitive, and psychomotor. The systematic literature shows that there are no publications being published from the year 2018 to the year 2022 which discuss the current impact of gamification in Mathematics in terms of psychomotor. Besides that, there are 3 research papers that discuss the impact of gamification on Mathematics subjects in terms of affective only whereas there are 2 research papers that stated the cognitive aspect only.

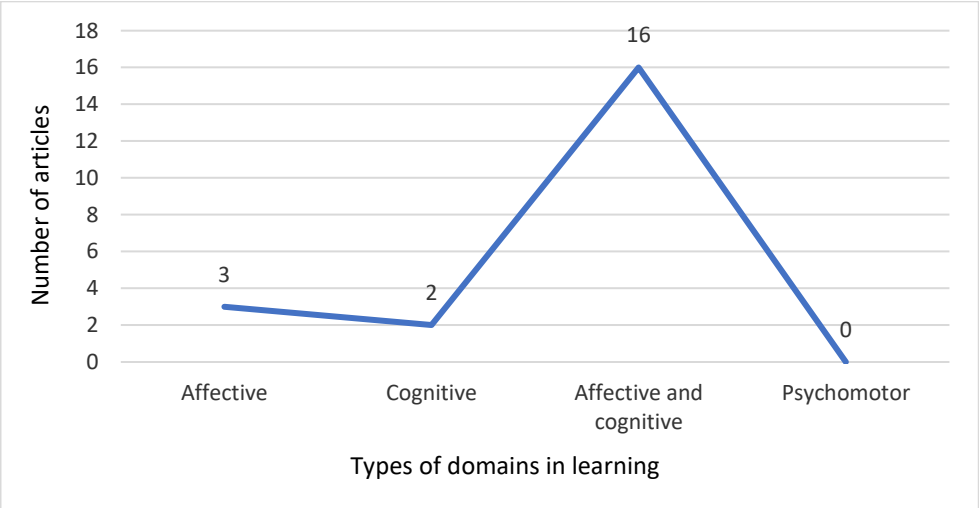

Figure 5. Number of articles published based on the impact of gamification on Mathematics subject in terms of affective, cognitive and psychomotor

Discussion

Discussion of the First Objective

Practicality refers to the game element in the education field which increases drastically within these few years. Significantly, gamification in Mathematics can be seen within various platforms such as *Kahoot, Quizziz* and *Blooket.* This can be proven based on the research conducted in 7 research papers which is almost 33% of the total number of research papers submitted in the year 2011. However, only 3 research papers are related to the research topic in the year 2022 which is revised in the mid-year. There are possibilities that there are still research papers that are still undergoing publication processes. Henceforth, it can be forecast that there would be an increase in the submission of research papers to a total of 10 papers or more towards the end of the year.

Revising the number of research papers in the year 2018 to 2020, the total number of research papers in 2020 decreased to a total of 4 publications. This is due to the start of the pandemic era in which all countries are required to conduct online learning (Rincon-Flores

et al., 2022). Even though many researchers are rushing to complete their research at the time, the database would only record reliable works submitted. The pandemic era also rushes researchers to reconsider and find alternatives in conducting and obtaining reliable and legible research findings. In short, gamification trends especially in Mathematics learning are proven to be very important based on the numbers recorded within this research.

Discussion of the Second Research Objective

Based on the 21 chosen research papers from various countries, the findings show that Spain is the country that would most likely apply gamification in Mathematics learning. Malaysia is the second country prone to apply gamification in Mathematics learning. In order to ensure technological integration in education, the first shift carried out by the Ministry of Education of Malaysia in *Pelan Pembangunan Pendidikan Malaysia* (PPPM) is to focus on providing equal access to high-quality, international-level education and to increase the quality of four subjects which are: Science, Technology, Engineering, and Mathematics. (Kementerian Pendidikan Malaysia, 2017). Within this shift, the ministry stated the need of exploring various educational models which make use of different modes that incorporate technology to enhance the students' learning quality. Therefore, it is clear that gamification research in Mathematics learning in Malaysia will increase within the next five years. It is also predicted that the number of research papers related to the field would slowly increase in Malaysia based on the demands by the stakeholders, teachers, and students on the effectiveness of gamification despite some research that stated otherwise.

Besides that, Frog VLE, an innovation in education that is developed alongside current technological advancement had been implemented by the Ministry of Education in all schools throughout Malaysia in the mid-year of 2013. The glory of Frog VLE however does not last long and ended in the mid of 2019 (Majid & Hasim, 2019). The end of the program led to various use and methods of gamification as an alternative to the learning process. Henceforth, the phenomenon also led to an increase in gamification-related research papers in Malaysia among researchers in order to identify the effectiveness and relevancy of the use of gamification tools in Malaysia, with aims to replace Frog VLE.

Discussion of the Third Objective

Based on the systematic literature, it was found that primary school students were the most popular group of respondents in conducting gamification research in Mathematics learning. This can be explained as the policy or education plan contributed as one of the main factors in choosing the research samples. 21st-century learning (PAK21) is one of the MOE's initiatives to enforce student-centered learning approaches based on five main elements which are communication, cooperation, critical thinking, creativity and ethical values. 21st-century learning defined the related knowledge, efficiency, and characteristics that need to be explained by students, competitively in order to cater to the current challenges of the world (Sulaiman & Noor, 2020). The approach was included in the second shift of the 2013-2025 PPPM document which aspires to provide students towards the Industrial Revolution 4.0 (4IR). Instead, it pushes teachers to follow the MOE's orders to apply gamification tools in the teaching and learning process of primary school students.

In addition, upon analysing the number of respondent groups for both secondary and tertiary level students, it was found that both groups are lacking in exposure to gamification. Even

though the research papers were proven to provide effective impact in terms of effectiveness and practicality as well as affective and cognitive aspects of the respondents, the effectiveness was not shown vividly in researches conducted. As students grow older, their cognitive aspect developed as well. The impact of rewards from gamification tools can no longer attract their interest to learn especially within their cognitive aspect. Besides that, when the mathematical conceptual knowledge gets more complicated and harder to be presented via gamification tools, the researchers faced difficulties in choosing these two groups as respondents in their research in using ever ready gamification tools. Due to the mentioned situation, these researchers had to invent their own gamification tools such as the *MiniBool* (Jiménez-Hernandez et al., 2020) in order to cater to the needs of students' mathematical knowledge. This shows how secondary teachers and even lecturers had to allocate plenty of time to come up with their own gamification tools for each different mathematical knowledge. Even if this is possible but the situation is unwise in terms of teaching preparation and the effectiveness of learning.

Discussion of the Fourth Objective

As a whole, one of the findings of this research found that gamification can increase motivation, involvement in learning and students' academic achievements in various levels of learning even though three research papers (Cakiroglu & Guler, 2021; Karamert & Vardar, 2020; Reyssier et al., 2022) proven that gamification does not affect students' learning attitude (Karamert & Vardar, 2020) and high achievers (Cakiroglu & Guler, 2021). The balance of the formation of gamification tools includes various segments (mechanical, dynamic and aesthetic) can be said to be helpful for students to become motivated and able to engage themselves in learning, thus supporting the SDT theory emphasised in this systematic literature.

The impact of gamification approach to Mathematics learning in terms of affective and cognitive domains are largely seen. Based on the statement, the SDT theory proposed that intrinsic motivation (affective) leads to voluntary students' involvement in learning thus setting the goal to achieve the learning objective as well as to achieve good academic development (cognitive). This proves that the research papers mentioned in this systematic literature links both affective and cognitive domains. However, no research has been found to prove the effectiveness in terms of psychomotor. This shows that more research should be conducted to determine the influence of psychomotor domain among students towards gamification trends in Mathematics learning. However, there is a possibility which oppose the aims as psychomotor is not the main focus of the chosen respondent groups. Hence, leading to no research conducted to report on the mentioned domain.

Conclusion

The findings of this research show that the gamification trends started to develop rapidly and was frequently used in Mathematics starting from the Covid-19 pandemic in the year 2020. The situation causes desperate measures to be taken especially in gamification approach after its necessity and impact was seen to be crucial for learning process. Secondly, Spain is the country which is the most frequently used gamification in Mathematics learning, consequently placing Malaysia as the second. Thirdly, the main impact of gamification in Mathematics can be seen from the blend of both affective and cognitive domains. At last, the emergence of national education policy has led to the choosing of primary school

students as the main respondent groups to conduct the research.

This research also has a few implications which are knowledge implication, theory implication and practical implication. Firstly, the knowledge implication can be seen in previous gamification trends in Mathematics, which can be handled more efficiently as the respondent groups are from various backgrounds with different disciplines hence providing more understanding of this complex topic. Therefore, the findings of this research would contribute to the development of future research related to the measurement of gamification impact and to support more developed gamification designs. In terms of theory implication, the SDT theory that was indirectly applied for better understanding of the integration of gamification in Mathematics learning can be largely expanded. Not only that, the practical implication shows that the related information gathered can be used as reference for the MOE, stakeholders, schools and even teachers. The main objective is to vary the process and the learning experience of students. As gamification is proven to provide benefits for various aspects, teachers should consider gamification approach in teaching Mathematics so that students can understand Mathematical concepts better and clearer.

However, this research has two limitations. First, the logical indication classifies the impact to gamification in Mathematics to be quite challenging. Therefore, this systematic literature suggests that the impact indication to gamification should be varied. The domains can be divided so that the findings of the empirical research conducted can be viewed more comprehensively. Besides that, the empirical research related to gamification approach in Mathematics should focus more on the impact of psychomotor. The probability of different respondent groups providing different findings would be higher due to the fact that each group ages' psychomotor are varried from each other.

This research proposes that the impact of gamification in various learning aspects should be varied. The division of domains can also be conducted in other methods so that the findings of empirical research can be seen more comprehensively. Besides, the empirical studies related to gamification in Mathematics should focus more on the impact of psychomotor as different respondent groups would provide the studies with different outcomes as each respondent groups have different psychomotor ability.

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