REVISTA DO PROGRAMA DE PÓS-GRADUAÇÃO EM EDUCAÇÃO MATEMÁTICA DA UNIVERSIDADE FEDERAL DE MATO GROSSO DO SUL (UFMS)

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Mapping of publications on Gamification and Mathematics

Mapeamento das publicações sobre Gamificação e Matemática

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ABSTRACT

This work presents the result of an investigation carried out in scientific publications, on how gamification has been used in the teaching of Mathematics. A mapping was carried out in Google Scholar databases, CAPES Theses and Dissertations Catalog, CAPES Portal of Periodics, Computers & Education Journal, Hal Platform and SciELO. After analyzing the publications, based on previously elaborated questions, we selected 38 of them. It was noticed that Elementary School is the level at which the greatest amount of gamified proposals are developed and teachers chose to use the computer in most of them. It was found that 66% of the works propose gamification using different resources and/or platforms in the preparation of gamified proposals and 34% propose gamification based on the use of games on digital platforms or gamified activities. Most gamified proposals aim at motivating and engaging students to learn the concepts of Mathematics.

KEYWORDS: Gamification. Teaching. Mathematics. Mapping.

RESUMO

Neste trabalho, apresenta-se o resultado de uma investigação feita em publicações científicas, sobre como a gamificação tem sido utilizada no ensino de Matemática. Foi realizado um mapeamento nas bases de dados Google Acadêmico, Catálogo de Teses e Dissertações da CAPES, Portal de Periódicos da CAPES, Revista Computers & Education, Plataforma Hal e SciELO. Após a análise dos trabalhos, a partir de questões elaboradas previamente, selecionamos 38 deles. Percebeu-se que o Ensino Fundamental é o nível em que são desenvolvidas a maior quantidade de propostas gamificadas e os professores optaram por utilizar o computador na maioria delas. Constatou-se que 66% dos trabalhos propõem a gamificação utilizando diferentes recursos e/ou plataformas na elaboração das propostas gamificadas e 34% propõem a gamificação a partir do uso de jogos em plataformas digitais ou atividades gamificadas. As propostas gamificadas, em sua maioria, visam motivar e engajar os estudantes para a aprendizagem dos conceitos de Matemática.

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PALAVRAS-CHAVE: Gamificação. Ensino. Matemática. Mapeamento.

Introduction

Gamification is a widely used strategy nowadays to motivate people in performing various activities, such as training, courses, in learning foreign languages, as is the case with Duolingo[3]. Boller and Kapp (2018, p. 41) point out that "Gamification is effective when you want the individual to stay engaged with the content or the experience for a long period of time." Given this, it can be seen that this is an interesting strategy that can be used in a variety of contexts, including educational.

Gamification can be used in the educational context to motivate students and engage them in performing an activity. According to Barbosa, Pontes and Castro (2020), the learning incentive generated by the use of gamification is due to several game elements, such as mechanics, reward systems, levels, time, and narrative, among others, which encourage students' engagement in the study of mathematical concepts. From this perspective, gamification can be used in several disciplines, such as Mathematics, to engage students and motivate them to learn the concepts.

Gamified proposals can be planned with or without the use of Digital Information and Communication Technology (DICT). This depends on the resources available, the goal to be achieved and the creativity of the teacher in planning these activities.

From this perspective, this paper aims at presenting the results of an investigation of scientific publications on how gamification has been used in mathematics teaching. To this end, a mapping was performed in order to identify studies on this topic and analyze them. Considering the potential of gamification, the next section presents some reflections on this strategy, followed by the methodology used, the analysis and systematization of results, the final considerations and references.

Gamification

Gamification is an important strategy that can contribute to the teaching and learning process of mathematical concepts. According to Alves (2015, p. 98), gamification is "[...] the use of game-based mechanics, aesthetics, and thinking to engage people, motivate actions, promote learning, and solve problems". Boller and

[3] Platform/application for language learning (https://pt.duolingo.com/).

Kapp (2018, p. 41) point out that “Gamification is about the use of game elements in a learning situation; the use of parts of a game in instructional design, without implying the creation of a complete game.” Thus, it can be seen that the concept of gamification is supported by the use of game elements to create gamified learning situations, that is, the use of game elements to enhance an experience.

Burke (2015, p. 62) emphasizes “Gamification motivates people during the long learning process and expands the classroom environment to provide learning opportunities for geographically dispersed students with varied abilities.” Hence, it can be seen that gamification is a strategy that, if used in the teaching and learning process, has the potential to motivate students and contribute to the learning of concepts. According to Alves (2015), motivation is an important element when talking about gamification and learning, because people get involved and devote time to a certain activity in search of fun and positive emotions.

By using elements of games, gamification has the ability to make the process of the subject’s relationship with knowledge more fun and enjoyable, thus increasing their level of commitment and engagement (BUSARELLO, 2016). Corroborating this idea, Barbosa, Pontes and Castro (2020, p. 1608) highlight that

> Gamification has the ability to contribute to the teaching of mathematics due to the use of different elements of games, such as the creation of goals, the use of specific rules, and the use of feedback, the point scale, the ranking; in addition to the competitive stimulus between students, which entails as a motivating factor to mathematical learning.

Alves (2015) stresses that gamification is a learning strategy that enables the achievement of a learning objective in an interactive and fun way. According to Boller and Kapp (2018, p. 41), “Gamification is effective when you want the individual to stay engaged with the content or experience for a long period of time." In this perspective, Alves (2015) highlights that gamification will be effective in the teaching and learning process if it is used to achieve specific objectives

The essence of gamification, according to Busarello (2020), is not in the technology, but in an environment that stimulates the diversity of learning paths, decision and reward systems, thus raising motivational and engagement levels.

In light of the above, it can be seen that gamification is a strategy that, if used properly, combined with good planning and having clear objectives to be achieved, can motivate students, engage them in performing the activities, and contribute to the learning of concepts.

Methodology

This study, of qualitative approach, consists of a mapping of productions on the theme gamifications and Mathematics, which aims to present the result of an investigation carried out in scientific publications, on how gamification has been used in teaching Mathematics. As the object of study is work articles already published in the literature, this study is characterized as bibliographic. According to Marconi and Lakatos (2003, p. 158), “The bibliographical research is a general overview of the main works already carried out, which are important because they are able to provide current and relevant data related to the topic.”

A mapping was performed, which, according to Fiorentini et al. (2016, p. 18), is “[...] a systematic process of survey and description of information about the research produced on a specific field of study, covering a certain space (place) and period of time.” In order to perform the mapping, the steps proposed by Proença Júnior and Silva (2016) were followed: (1) searching references, (2) collecting references, (3) filtering references and (4) reporting results.

For this mapping, the following databases were consulted: *Google Scholar*, CAPES Theses and Dissertations Catalog, CAPES Portal of Periodic, Computers & Education Journal, Hal Platform and SciELO. In these databases, searches were performed using “Gamification *AND* Mathematics" as searching terms. The papers found were downloaded so that it was possible to analyze them in their entirety, and a summary of them is presented below.

To analyze these publications, in addition to the goal of investigating how gamification has been used in mathematics teaching, a few more questions were listed to guide the analysis: At which grade level has gamification been most used in mathematics teaching? What mathematics content is most often covered? Has gamification been most often used with or without the use of digital technologies? What types of resources are used in the development of gamified proposals?

Results – Analysis and Systematization

This topic presents the results of the mapping of scientific production on the topic of gamification and mathematics. Sixty-six papers were found using the search terms “Gamification *AND* Mathematics”.

After extracting the manuscripts from the databases, a first screening of these papers was performed. Initially, those that were not available online, those that were not available in full, and duplicates were discarded. These exclusion criteria were adopted because versions of the same paper were found in more than one database.

In addition, preference was given to analyzing the full version of the articles, since the summarized version did not include the answers to the guiding questions.

Next, the title, abstract and keywords of each manuscript were read. This step aimed at analyzing whether the papers found were in accordance with the terms “Gamification *AND* Mathematics”, i.e., whether they dealt with the use of gamification in teaching mathematics, according to their authors. In this step, 28 manuscripts were discarded for not being related to the search terms (as being from other areas such as Biology, for example) or not meeting the established criteria. Thus, 38 papers remained, considering the databases consulted, as shown in Table 1.

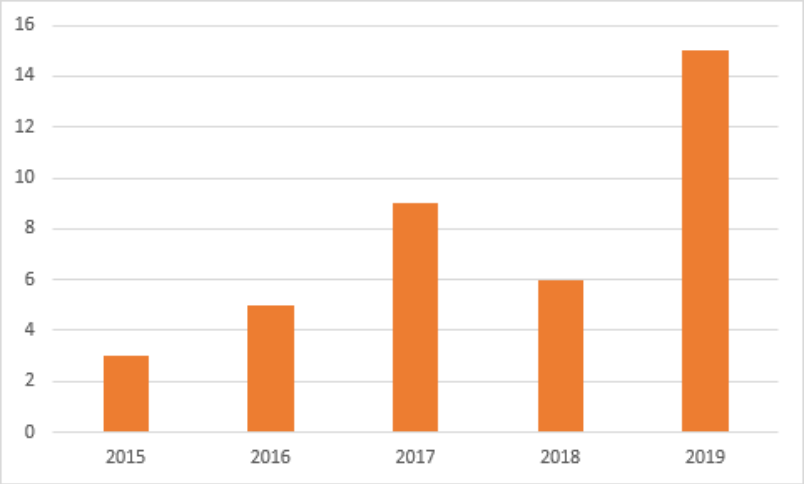
Table 1 – Number of papers included and discarded from the analysis

Data Base	**Included**	**Discarded**
Google Scholar	17	12
CAPES Thesis and Dissertation Catalog	17	9
CAPES Portal of Periodics	3	6
Computers & Education Journal	1	0
Platform Hal	0	1
SciELO	0	0
Total	38	28

Source: created by the authors, based on the data collected.

Analyzing the data in Table 1, it can be seen that the largest number of papers analyzed was from Google Scholar (45%) and the CAPES Thesis and Dissertation Catalog (45%), followed by the CAPES Portal of Periodic (8%) and Computers & Education Journal 2%. Figure 1 shows the years of publication of the analyzed manuscripts.

Figure 1 – Graphic of the Year of publication of each Manuscript



Source: created by the authors, based on the data collected

The analysis of Figure 1 allows us to notice that the number of productions related to gamification and Mathematics has been increasing, corroborating the results found by Barbosa, Pontes and Castro (2020). The largest number of publications was in 2019, with 15 papers, followed by 2017, with 9. Thus, it can be seen that this is a current theme, since research on this topic is still being conducted.

In order to have an overview of the publications, they were grouped into two categories. The first category, Chart 1, is composed of theses, dissertations and course completion papers. The second category, Chart 2, is made up of academic articles published in events or periodicals.

Chart 1 – Category 1: Theses, Dissertations and Course completion papers

Type of work – Title	**Authors**	**Objectives**
Thesis - Design of gamification in computationally supported collaborative learning: an approach for adapting influence principles to player roles	Simone de Sousa Borges (2017).	Investigate whether principles of influence can support the use of game elements to harness student susceptibility to persuasion.
Dissertation - Khan Academy: possibilities of using the game as a pedagogical support tool in teaching and learning fractions in elementary school.	Valdeci da Silva Araújo (2017).	To analyze the viability of the Khan Academy platform as a pedagogical support tool, through games, in order to verify whether the use of this resource can motivate and enhance the learning of elementary school students in the content of Fractions in Mathematics.
Dissertation - Use of gamification in virtual learning environments to reduce the problem of externalization of undesirable behaviors.	Laís Zagatti Pedro (2016).	Study and define an alternative to decrease undesirable behavior in systems using gamification techniques.
Dissertation - Educational gamification for adolescents with intellectual disabilities.	Valnira Aparecida Alves de Oliveira (2016).	To investigate the facilitation of the learning process of basic mathematics for adolescents with intellectual disabilities, through the resources of gamification.
Dissertation - Proposition of gamification models for online gamification systems: an evidence-	Amaury Nogueira Neto	To analyze high school students with the intention of evaluating the impact of the use of gamification elements, point, trophy and

based education approach	(2016).	ranking in relation to their engagement, in the context of teaching the subject of high school mathematics.
Dissertation - Gamification and Mathematics Education: a reflection from the perspective of the Theory of Didactical Situations.	Marcelo dos Santos Gomes (2017).	Promote the articulation between the Theory of Didactic Situations and gamification in order to highlight and identify possible relationships between them and, consequently, assist the use of gamification as a teaching strategy based on the TDS.
Dissertation - The use of gamification as a didactic strategy in teacher training for the use of educational software.	Bruno Santos Ferreira (2015).	To verify the effectiveness of gamification in the situation of teacher training for the use of SE GGBOOK, through the consideration of Kolb's learning styles (1984).
Dissertation - Use of Gamification in Open and Massive Online Courses for Mathematics Teachers' Continuing Education	Janaina Aparecida Ponté Coelho (2017).	To investigate and understand if the elements of gamification applied in courses in MOOC's methodology are able to enhance the interaction and engagement of mathematics teachers in Continuing Education courses.
Dissertation - The use of gamification techniques as an aid to Problem Solving in the field of Combinatorial Analysis.	Igor Pereira Aguiar (2019).	To validate the use of gamification and Problem Solving techniques as a support for teaching and learning Combinatorial Analysis on mobile devices.
Dissertation - Gamification in Mathematics teaching: an experience in Elementary School	Hugo Carlos da Rosa Esquivel (2017).	To investigate what is gamification and which paths it can take regarding its applications in Mathematics education in Elementary School.
Dissertation - Gamification in Mathematics teaching: learning the Multiplicative Field	Ilson Mendonça Soares Prazeres (2019).	To analyze the gamification strategy allied to mobile devices as mediators for teaching and learning of Mathematics.
Dissertation - Gamification in Mathematics teaching: proposals for teaching Matrices through an alternate reality game.	Pedro Gurgel Moraes (2017).	To verify if it is possible to create a gamified environment for teaching Matrices.
Dissertation - The challenge of teacher education: potentialities of gamification allied to GeoGebra.	Rafaela Padilha (2018).	To develop and evaluate a training program for teachers of Basic Education with a view to the insertion of gamification in Mathematics teaching allied to the GeoGebra software.
Dissertation - Contributions of gamification to teaching and learning: a teaching proposal for Financial Mathematics.	Daniel de Melo Jacobsen (2018).	To verify the feasibility of implementing a gamified Teaching and Learning Unit (UEA) in the Moodle platform, with a view to teaching and learning Financial Mathematics concepts.
Dissertation - Extraction and recommendation of good and bad pedagogical practices from teaching and learning processes using a gamified Intelligent Tutor system.	Sivaldo Joaquim de Santana (2017).	To extract good and bad pedagogical practices from teaching and learning processes using a gamified Intelligent Tutor System in Primary Education.
Dissertation - Proposal of a Mathematics Virtual Learning Environment (VLE) for the National High School Exam (ENEM).	Luis Paoli Schiffino Gomez (2015).	To show that it is still possible to innovate in the teaching of mathematics supported by technologies, focusing on the content required in ENEM.
Dissertation - The use of mobile learning and gamification techniques to support the teaching of Matrices.	Jorge Luiz Cremontti Filho (2016).	To develop and validate an application that helps the user of smartphones and tablets in the study of Matrices, based on concepts of mobile learning and gamification techniques.
Dissertation - The use of gamification in learning mathematics: a case	Paulo Alexandre	To apply the concept of gamification to the learning of the Trigonometry content domain.

study.	de Andrade Vieira (2019).	To evaluate, as far as possible, the impact of the gamification strategies used.
Dissertation - Gamification of mathematics lessons by eighth grade students.	Thais Cristine Andreetti (2019).	To investigate how the process of gamification of mathematics teaching situations occurs when these are designed and carried out by students of an 8th grade of elementary school.
Dissertation - Gamification as a teaching strategy: the perception of mathematics teachers.	Luiz Otavio Rodrigues Mendes (2019).	To unveil the possibilities of gamification as a strategy in the teaching and learning processes of mathematics.
Course Conclusion Paper - Gamification inserted as support material that stimulates the student in mathematics teaching.	Ana Paula Nunes Medeiros (2015).	To verify the effectiveness of the support material: gamification, to arouse the student's interest in teaching mathematics, using it in such a way that his actions within the Virtual Learning Environment have an impact on his teaching-learning process.

Source: prepared by the authors based on the collected data.

An analysis of the objectives of theses 21 publications in Chart 1, shows that the intention of most of them was to develop and/or apply some resource (such as platforms and games) using gamification elements and/or gamified activities to gamify mathematic classes at various levels of education. It is also noteworthy that the focus of most of these works was the teaching of Mathematics in Basic Education, since only four of them, Mendes (2019), Padilha (2018), Coelho (2017) and Ferreira (2015) deal with proposals for teacher training.

In Chart 2, it is highlighted the second category composed of academic articles published in periodicals or events. Also in this chart, the type of work, title, respective authors and objectives are highlighted, aiming at having an overview of these publications.

Chart 2 - Category 2: Articles

Type of work – Title	Authors/year	Objectives
Article - Math mobile app for elementary school children from 1st to 3rd grade.	Aldenia da Silva Marinho, Alexander Von Cernik Melo, Gianpierre Herrera Poggi, Marianne Bállico Kosiur, Wagner Rosa Marrane, Cláudio Boghi (2016).	To present a case study of software development to support the teaching of Mathematics.
Article - Classcraft: learning that becomes a permanent challenge!	Dora Sofia da Cunha Freire, Ana Amélia Amorim Carvalho (2019).	To describe the implementation of a gamified learning module to stimulate competition among students and that would lead to greater motivation for learning in the subject of Mathematics.
Article - Gamification in Mathematics Teaching: from the Curricular Guidelines of Paraná to the classroom, via Teaching Work Plan	Merris Mozer, Eliza Adriana Sheuer Nantes (2019).	To develop and apply, in the classroom, a Teaching Work Plan, suggested by the Curriculum Guidelines of the State of Paraná, having as programmatic content the

		Plane Geometry in the subject of Mathematics.
Article - Examining competitive, collaborative and adaptive gamification in young students' mathematics learning.	Tomislav Jagust, Ivica Boticki, Hyo-Jeong So (2018).	To identify the impacts of different types of gamified learning activities - competitive, collaborative and adaptive - in elementary school mathematics classes.
Article - Flipped learning and gamification: two engaging methodologies for teaching mathematics.	Daniela Guimarães, Idalina Lourido Santos, Ana Amélia Amorim Carvalho (2018).	To analyze the contributions of flipped learning and gamification combined with the integration of digital educational tools, in motivating students and promoting more active learning.
Article - Streamlining a math event from the perspective of gamification.	Luiz Otavio Rodrigues Mendes; Emerson Blum Corrêa; Luciane Grossi; Fabiane de Oliveira (2018).	To analyze the receptivity of subjects in a mathematical event, with activities from the perspective of gamification.
Article - A study on the use of gamification in teaching mathematics in elementary school.	Lucio Luzetti Criado, Nelson Luzetti Criado, Maria Aranha de Souza (2019).	To construct educational games, by 9th grade students, to be used as a strategy for teaching Mathematics in 5th grade of elementary school.
Article - Gamification: a tool for teaching mathematics.	Sógenes Geraldo da Silva Pereira, José de Aquino Santos, Helder Lima Silva (2019).	To stimulate the teacher, especially of Mathematics, to reflect about gamification as a teaching-learning strategy.
Article - Gamification of Mathematics in the Federal Institute of Amazonas.	Gabriel Pinheiro Compto, Francisco Lucas Lima Sena (2019).	To highlight the importance of the development of digital games for the teaching and learning process of Mathematics.
Article - Gamification of mathematics classes	Jorge Santos, Leandro Nascimento, Rafael Costa, Wagner Santos, Luciane Velasque (2017).	To contribute to a reflection on the part of Basic Education teachers who seek support to provide a better implementation of learning situations in their classrooms.
Article - Proposal for the application of an extension course in Mathematics using Bloom's Taxonomy and gamification as Active Methodologies: a case study.	Ramon Oliveira Borges dos Santos, Luana Maryan de Almeida Rodrigues de Souza, Regina Elaine Santos Cabette (2019).	To develop learning methods with students so that they can objectively and effectively understand essential Math topics that will be covered in the following years.
Article - Gamification and technology in mathematics teaching.	Daniel Lisboa de Menezes, Rafael José Alves do Rego Barros (2019).	To develop a digital game that uses gamification as a way of learning Mathematics in Federal Educational Institutions.
Article - Gamification in Mathematics: contents addressed with the strategy by teachers from Paraná.	Luiz Otavio Rodrigues Mendes, Emilly Gonzales Jolandek, Luciane Grossi, Mary Ângela Teixeira Brandalise (2019).	To show which mathematical content has been most often addressed with gamification in the state of Paraná, as well as to investigate the development of its application.
Article - Gamification in Mathematics: one of the possible solutions amidst so many discussions.	Fabrício de Oliveira Lima, Daniel Nicolau Brandão (2019).	To present gamification as a tool capable of facilitating the teaching of mathematics in schools.
Article - SAM platform: gamification and collaboration in a learning platform for teaching Mathematics to children with Down Syndrome.	Antonio Victor Alencar Lundgren, Zildomar Carlos Félix (2017).	To present the SAM Platform, a web-based learning platform, gamified and collaborative, aimed at teaching Mathematics to young people and children with Down Syndrome.
Article - The digital game as a proposal of gamification in the	Thomas Bersagui Milano, Mirian Linhares Siqueira,	To describe the functioning of a digital game that acts as a

teaching of History of Mathematics.	Fernanda Chites Azevedo, Lucas Nunes Ogliari (2019).	gamification proposal in the teaching of this subject, with the purpose of motivating the students and influencing the learning process.
Article - Gamification in elementary mathematics education: a systematic review of the literature.	Rafaella Alves Pereira dos Santos, Roberto Felício de Oliveira (2018).	To provide an overview of the applicability of gamification in Basic Mathematics education.

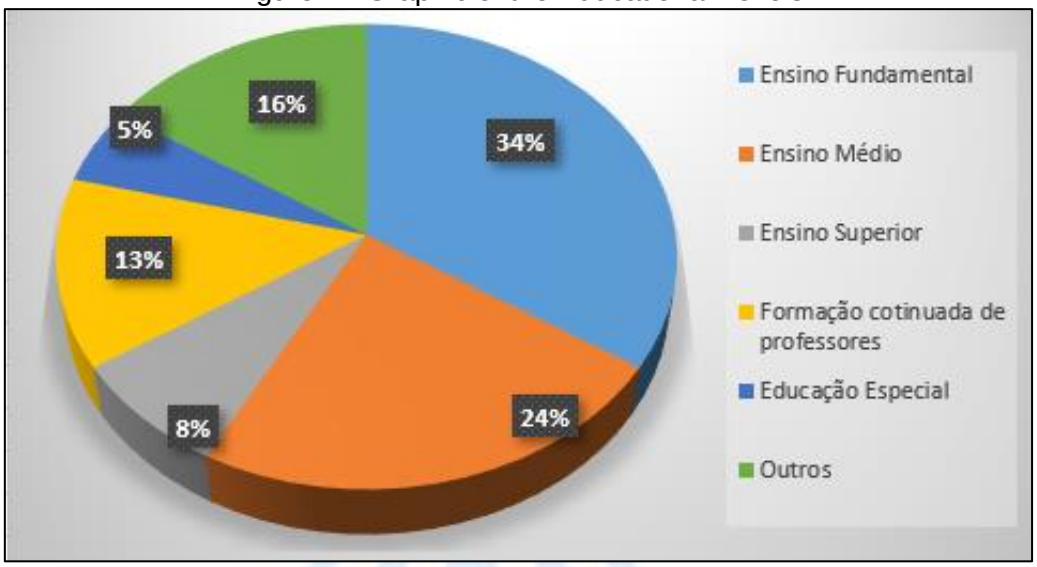
Source: prepared by the authors based on the collected data.

The analysis of the objectives of the 17 articles presented in Table 2 shows that their focus was the development of gamified proposals to be used in the teaching of mathematics, aiming to motivate students and assist in the learning of contents and concepts. Another relevant aspect is that, in the work of Mendes et al. (2018), the authors developed a gamified proposal in a mathematical event with the aim of engaging the participants of this event. It is noteworthy that only three among the 17 manuscripts analyzed - Milano *et al.* (2019), Santos *et al.* (2017) and Pereira, Santos and Silva (2019) - deal with proposals that focus on the initial and/or continued training of mathematics teachers.

In general, of the 38 publications analyzed in the survey, only seven are proposals developed in the initial and/or continuing education of mathematics teachers. These results corroborate those found by Ritter and Bulegon (2020) in a review conducted on the same theme. These authors point out that there is little research on gamification that has been conducted in the initial and continuing education of mathematics teachers., stressing “[...] the importance of conducting studies on gamification, because it is a teaching strategy that if used properly can motivate students and engage them in the study of contents/concepts.” (RITTER, BULEGON, 2020, p. 9).

An analysis of the educational levels in which the papers proposed activities and/or developed proposals was also carried out, to get an idea of which educational level gamification is most used. The results can be seen in Figure 2.

Figure 2 - Graphic of the Educational Levels



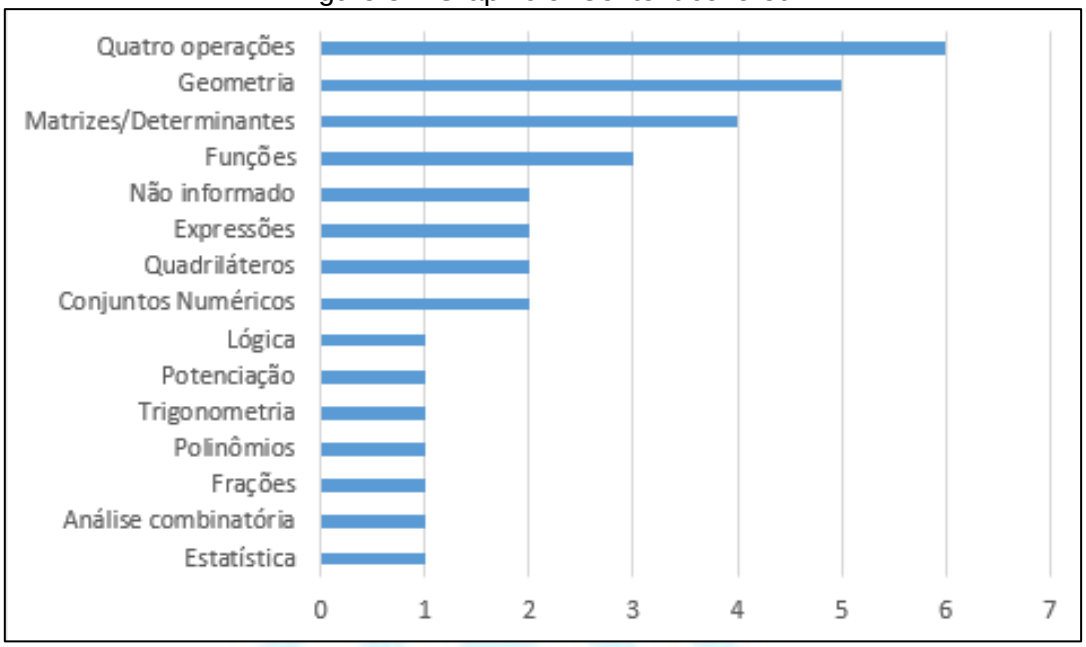
Source: prepared by the authors based on the collected data.

Figure 2 shows that Elementary School (34%) is the school level with the most gamified proposals, followed by High School (24%). Another relevant aspect was the use of gamification in Special Education (5%), showing that gamification can be used in several contexts to help students learn concepts and acquire knowledge. It should be noted that the "others" category is made up of papers that have not been applied to any of the aforementioned educational levels, being theoretical approaches, surveys or state-of-the-art.

From the analysis of the educational levels in which the research was developed, it can be concluded that most publications developed gamified proposals in elementary school. These results corroborate the research of Santos and Oliveira (2018), who conducted a survey on gamification and found that it is used more in elementary school than in high school.

The most covered mathematical contents in the Elementary and High School levels were categorized and are presented in Figure 3.

Figure 3 – Graphic of Content covered

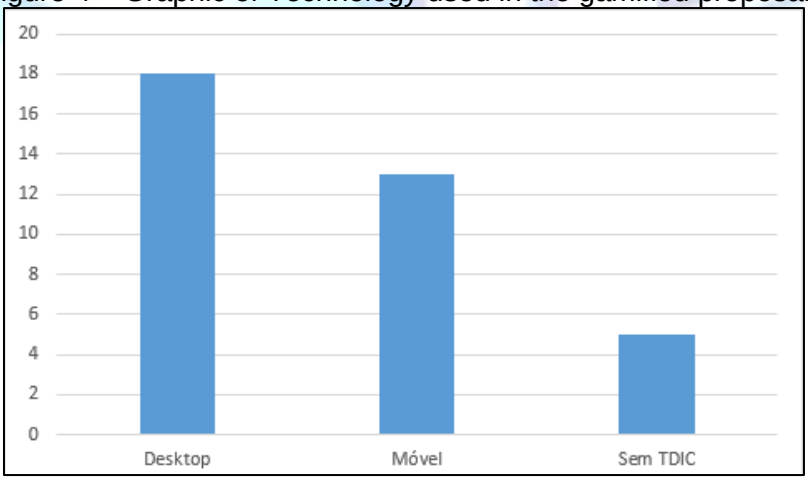


Source: prepared by the authors based on the collected data.

The analysis of Figure 3 shows that the Four Operations were the most addressed content in the analyzed works (6), followed by Geometry (5), Functions (3), Expressions (2), Quadrilaterals (2) and Number Sets (2).

We also analyzed how the gamified proposals were made: if ICT resources were used or if they were made without the use of technological resources. To this end, three categories were created: mobile (if mobile technology (cell phones and/or tablets) was used in the application of the proposal), desktop (works that used computers to support the gamified proposals) and without ICT (refers to works that created and applied gamified proposals without the use of digital technologies). The results of this analysis are shown in Figure 4.

Figure 4 – Graphic of Technology used in the gamified proposals



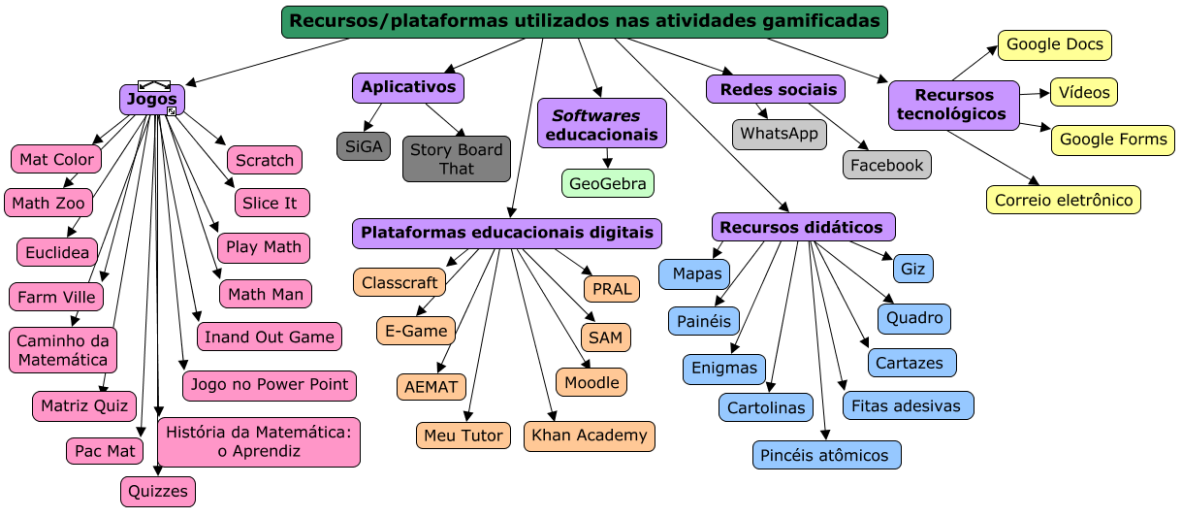
Source: prepared by the authors based on the collected data.

It is notable that, in the data presented in Figure 4, only works that applied gamified proposals were included, those that were theoretical or survey studies were not. In addition, some of the studies used more than one technology, such as mobile and desktop technology. Figure 4 shows that desktop was the most used technology (18), followed by mobile (13). Another relevant aspect is that gamified activities were also proposed without the use of ICT, which is also a possibility to engage students when technological resources are not available

In order to present an overview of the resources/ platforms used in the gamified proposals, these were classified into seven categories: games, applications, social networks, digital educational platforms, educational software, technological resources, and teaching resources.

The games category is made up of digital games that can be accessed on the web or by downloading the application. In addition, analog games also make up this category. Applications are understood here, as resources that can be installed on mobile devices and are not games. Social networks include Facebook, WhatsApp, Instagram, and others. Digital educational platforms are online environments organized to meet a certain pedagogical objective. Educational software is software used for pedagogical purposes, such as GeoGebra, Ruler and Compass, among others. Videos, e-mail, Google Forms, and Google Docs form the technological resources category. Finally, the category 'Teaching Resources' is formed by non-technological materials used for pedagogical purposes, such as puzzles, maps, panels, posters, chalkboard, chalk, cardboard, tape, and permanent markers. The concept map in Figure 5 shows the resources/platforms identified in the productions analyzed.

Figure 5 – Resources/platforms used in the gamified proposals



Source: prepared by the authors based on the collected data.

An analysis of Figure 5 shows that a variety of resources and platforms were used in gamified proposals. It is noteworthy that, in some works, more than one resource was used. From the analysis of the manuscripts, one can see the use of gamification in at least two contexts in mathematics teaching: [1] from the use of games on digital platforms or gamified activities; [2] using different resources and/or platforms in the development of gamified proposals.

It is noteworthy that 34% of the works made use of games in the construction of gamified proposals for teaching mathematics. It should be noted that, according to Boller and Kapp (2018), gamification consists of the use of game elements in the creation of learning solutions, without requiring the creation of a full game. According to this definition, the construction of gamified proposals can be carried out using the elements of games, without using a game itself. It is also emphasized that it is important to be clear about the difference between gamification and game-based learning, since the latter consists of the use of games to support the teaching and learning process (CONTRERAS-ESPINOSA; EGUIA-GÓMEZ, 2016, p. 63).

It was also noticed that 66% of the manuscripts used game elements and/or proposed gamified activities using various resources (except games) such as Google Forms, puzzles, and others.

Final Considerations

The aim of this study was to present the results of an investigation of scientific publications on how gamification has been used in mathematics teaching. From the mapping carried out, it was possible to notice that Elementary School is the level of education where more gamified proposals are made, a result also found by Santos and Oliveira (2018). It was also evident that the Four Operations are the mathematical concept most often addressed in gamified proposals.

It was found that most teachers choose to use computers in the gamification of their classes. Moreover, that they use a variety of resources and platforms in the construction of gamified proposals to motivate and engage students.

Therefore, most of the productions analyzed have as their main focus the development of gamified proposals to be used in the teaching of mathematics, in order to motivate students, engage them in performing the activities, and help them learn the concepts.

It is also important to note that few studies were found focusing on the use of gamification in the initial or continuing education of mathematics teachers, corroborating the results of Ritter and Bulegon (2020). Thus, the need for further studies in this area is evident, since if teachers have knowledge about the use of gamification, they will be more likely to use it in their mathematics classes.

Finally, we emphasize that the implications and contributions of the use of gamification as a pedagogical strategy in mathematics teaching are subject of future research.

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