Digital Tools for Interactive Learning: A Systematic Mapping

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Abstract. In an increasingly connected and technological world, training methods give rise to new forms of teaching-learning. Seeking to innovate educational practices, several digital tools have been made available as a support resource for more accessible, interactive, and effective education. To identify the characteristics and functionalities of these digital tools, a systematic mapping was carried out on publications in journals and event annals over the last ten years that present the application of such tools in teaching-learning processes. The results obtained show that the Quiz is the activity model most present in the tools, and that there are gamification elements such as scoring, victory conditions and feedback mechanics. The mapping also made it possible to identify which gamification elements can be explored and which technologies have been used in development, providing a base of information that can be considered in the development of new digital tools.

Keywords: interactive learning, digital tools, systematic mapping.

Ferramentas Digitais para Aprendizagem Interativa: Um Mapeamento Sistemático

Resumo. Em um mundo cada vez mais conectado e tecnológico, os métodos formativos suscitam de novas formas de ensino-aprendizagem. Buscando inovar as práticas educacionais, diversas ferramentas digitais têm sido disponibilizadas como recurso de apoio para uma educação mais acessível, interativa e eficaz. Para identificar as características e funcionalidades dessas ferramentas digitais, foi realizado um mapeamento sistemático sobre publicações em periódicos e anais de eventos nos últimos dez anos que apresentam a aplicação de tais ferramentas nos processos de ensino-aprendizagem. Os resultados obtidos mostram que o Quiz é o modelo de atividade mais presente nas ferramentas, e que há elementos de gamificação tais como pontuação, condições de vitória e mecânicas de feedbacks. O mapeamento permitiu ainda identificar quais elementos de gamificação podem ser explorados e quais tecnologias têm sido empregadas no desenvolvimento, fornecendo uma base de informações que podem ser consideradas no desenvolvimento de novas ferramentas digitais.

Palavras-chaves: aprendizagem interativa, ferramentas digitais, mapeamento sistemático.

1. Introduction

Teaching, as a social practice that guides the development of knowledge, skills, and attitudes, has been transformed to meet the training needs of an increasingly

connected society, in which technological innovations are resources that assist in productive work processes (MELLO et al., 2021).

Since the Industrial Revolutions, Education has undergone several adaptations, characterized by educational models. The current model called Education 4.0 is based on combining pedagogical practices with technological resources, such as Educational Software, Digital Games, Digital Platforms etc., to develop students' protagonist (DE SOUSA OLIVEIRA E DE SOUZA, 2020).

The use of technologies in the educational area has an inherent characteristic of interactivity (PEREIRA et. al., 2017), which favors the role of the student as a builder of their knowledge, mediated by the teacher. According to Gonçalves and Loureiro (2017), the use of digital tools can motivate students to interact and develop the proposed activities, in addition to allowing the teacher to guide new ways of giving new meaning to their mistakes through learning resources.

In order to identify which digital tools have been used in teaching and their characteristics regarding resources, applications and technologies, a systematic mapping was carried out based on the methodology of Kitchenham and Charters (2007). The mapping searched for studies published in the last ten years and the search returned a total of 660 scientific works, of which 18 were selected as primary studies for analysis.

2. Methodology

The Systematic Mapping presented in this article aims to identify which available digital tools can be applied to assist the teaching and learning process through interactive activities.

Based on the methodology of Kitchenham and Charters (2007), the research method is characterized by the identification, selection, and synthesis of published studies on the subject. The results obtained allow us to analyze the state of the art, in terms of quantity and/or frequency of publications, as well as trends to be explored.

Following the steps of the methodology, when identifying studies, the Research Protocol was structured, defining: i) the research questions that guide the information to be extracted; ii) the search strings s that allow searching for key terms; iii) the research bases in which they will be applied; iv) and the selection criteria.

The study selection stage comprises the application of the protocol, selecting studies relevant to the mapping objective. The process begins by searching for strings in published studies using the defined bases. In the preliminary result, the selection criteria are applied, and, in the definitive result, each study is read in full.

In the study synthesis stage, the information obtained in the mapping studies is extracted and summarized, answering the research questions. Finally, an analysis of gaps and potential opportunities regarding the research subject is carried out.

2.1. Research Questions

To achieve the objective of this study, the following questions were defined:

Q1. What available digital tools can be applied to assist the teaching and learning process through interactive activities?

Q2. Are digital tools gamified? What gamification elements are incorporated into the tools?

Q3. What types of technologies do these digital tools use to operate?

2.2. Search Strategy

To carry out the research, strings were defined in English (EN) and Brazilian Portuguese (PT-BR), using a combination of terms congruent with the focus of this mapping, presented in Table 1.

Table 1 – Search strings defined in Planning.

Language	Search Strings
EN	"digital tool" AND "interactive activities"
PT-BR	"ferramenta digital" AND "atividades interativas"

Although the objective of the mapping is to identify digital tools that offer interactive activities to assist the teaching and learning process, the research did not return satisfactory results when combining the strings with terms referring to "education/learning/teaching". Therefore, they were not considered.

The strings were applied to the following scientific databases: ISI Web of Science, ScienceDirect Scopus, Scholar Google, ACM Digital and IEEE Xplorer. The result in the first search was 660 studies.

2.3. Selection Criteria

To select studies that effectively contribute to the mapping, the following Inclusion Criteria (IC) and Exclusion Criteria (EC) were defined:

- IC1. Studies on digital tools that allow managing interactive activities.
- IC2. Studies on digital tools applied to teaching and learning processes.
- IC2. Article-type studies, available, described in English and/or Portuguese.
- EC1. Studies on virtual/digital learning environments/objects, in which the resources are characteristic of a digital learning platform.
- EC2. Studies on gamification in digital learning tools or virtual learning environments/objects.
- EC3. Studies in other languages, duplicates, unavailable and/or that do not refer to the delimited topic.

With the application of the Exclusion Criteria, when reading the titles and abstracts of the studies, the result was reduced to 32 studies. For the final selection, the introduction and conclusion of the studies were read, applying the Inclusion Criteria, which resulted in 18 works for data extraction, listed in Table 2.

Table 2 - Result of studies obtained in mapping.

Base	Study		Ano
IEEE Xplorer	S01	Experience of using SMART technologies in university education.	2021
	S02	Project Based Teaching with Digital Tools in Primary Education.	2020
	S03	Influence of Gamification Reward System on Student Motivation.	2019
Scholar Google	S04	Creating the Conditions for Vocabulary Learning with Wordwall.	2022
	S05	Applying an Online Learning Platform to Enhance Students' Online Education Classroom Learning Experience during COVID-19.	2022
	S06	Avaliação formativa em contexto digital com tecnologias digitais interativas.	2022
	S07	O uso da plataforma Wordwall como estratégias no ensino de química.	2022

	S08	Exploring ways to create 21st century digital learning experiences.	2022
	S09	Jogo didático: a utilização do Wordwall® como abordagem metodológica para contribuição no processo de ensino aprendizagem.	2021
	S10	O Kahoot na Educação A Distância (EAD): Ferramenta Potencializadora do Engajamento dos estudantes do Curso de Licenciatura em Física nos conteúdos pedagógicos.	2020
	S11	Sistema Respiratório: Avaliação de ensino aprendizagem com a utilização da Plataforma Digital Kahoot!	2020
	S12	Mobile apps for ELLs: Supporting language learning with engaging digital tools.	2016
Scopus	S13	Teaching discourse markers in a technologically enhanced language classroom.	2018
Web of Science	S14	An Exploratory Study of Mobile-Based Scenarios for Foreign Language Teaching in Early Childhood.	2022
	S15	Information and Communication Technologies for Education Considering the Flipped Learning Mode.	2022
	S16	O ensino remoto emergencial e o uso de recursos digitais em aulas de língua inglesa.	2021
	S17	Digital Activities in Teaching/Learning a Foreign Language for Specific Purposes, Technical/Scientific Domain.	2021
	S18	The challenges of digitally-mediated Italian language and culture development: Engaging the online learner through gamification.	2018

3. Results

With the analysis of study data, it was observed that studies on the use of digital tools applied to teaching have been increasingly published in the literature, especially since 2019, as shown in the graph in Figure 1.

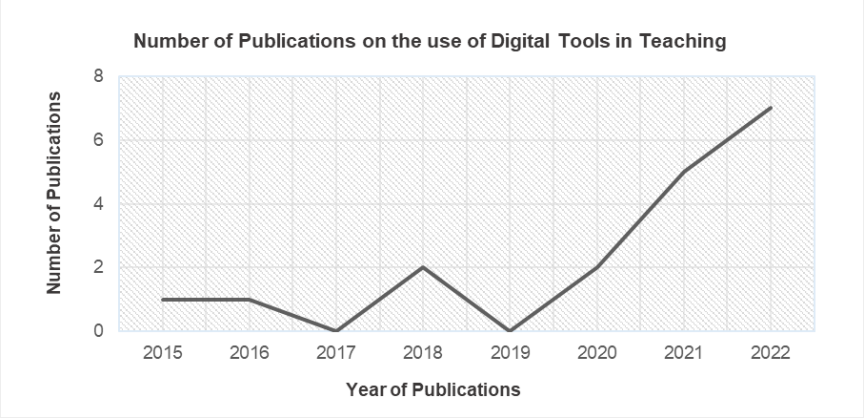

Figure 1 – Number of Publications on the use of digital tools in Teaching.

3.1. What available digital tools can be applied to assist the teaching and learning process through interactive activities?

The selected studies present several applications of digital tools available, free, or paid, that allow you to manage interactive activities. Table 3 shows that the most cited tool in the studies was Kahoot!, followed by Wordwall and Quizlet.

Table 3 - Digital tools cited in studies.

Studies	ID	Digital Tools	Number of studies that cite digital tools
S01, S02, S03, S08, S10, S11, S12, S14, S15, S16	F1	Kahoot!	10
S04, S07, S09, S16, S18	F2	Wordwall	04
S06, S08, S13	F3	Quizlet	03
S08, S15	F4	Socrative	02
S08, S18	F5	Padlet	02
S05, S08	F6	Nearpod	02
S14, S16	F7	Baamboozle	02
S13	F8	Quizizz	01
S06	F9	Mentimeter	01
S02, S17	F10	LearningApps	02
S12, S17	F11	Edpuzzle	02
S06	F12	Answer Garden	01

The studies present the application and results of using the tools, succinctly describing the functionalities of the digital tools. Therefore, to obtain the answers, access was also made to each of the identified tools and the resources from the free version were observed.

In general, digital tools are free and paid, varying depending on the type of resource to be used. It was found that 80% of the tools (F1, F2, F3, F4, F5, F6, F8, F9, F10, F11) are multilingual, have a mobile version and allow the student to access the activity without registering an account.

Regarding user profiles, approximately 50% of the tools (F1, F3, F4, F6, F8, F11) provide the role of teacher/student and allow working in both asynchronous and synchronous mode. Regarding the response mode, it was verified that Kahoot! is the only tool that allows you to send recorded audio. This limitation is presented in study S04 (Moorhouse and Kohnke, 2022), which describes that Wordwall focuses on the word-only response format.

Regarding the resources provided, it was found that at least 50% of the tools (F3, F4, F6, F8, F11) allow: i) creating interactive activities and classes; ii) share activities via links or directly in classes; iii) and view activity responses and the number of errors and successes from reports.

Regarding the types of activities available, it was observed that the Quiz is a format present in 90% of the tools, as shown in the graph in Figure 2. Other types identified were matching games, word searches, gallows, group classification, flash cards, crossword, memory test, multiple choice, anagram, word cloud, note board etc.

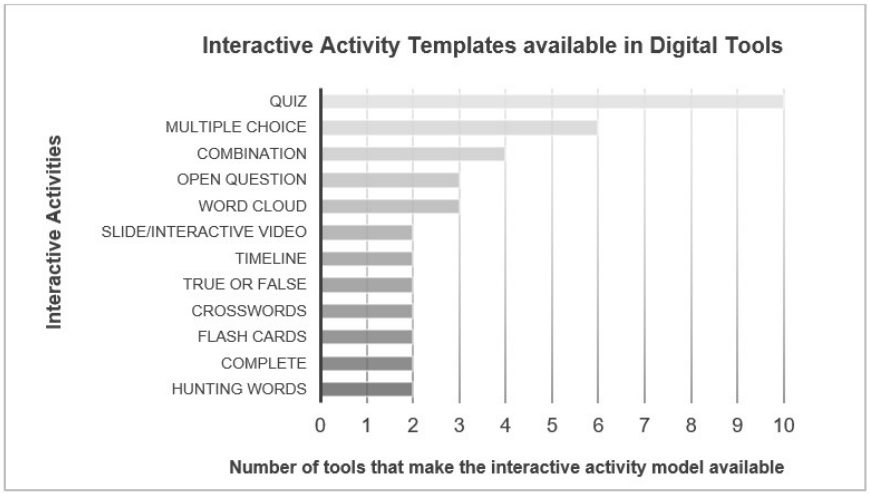

Figure 2 - Model of interactive activities available in the tools.

Regarding the objective of the tool, it was observed that some are more focused on the construction and presentation of content, such as Mentimeter, EdPuzzle and Padlet; and others are more aimed at practicing and evaluating content, such as Kahoot!, Wordwall, Socrative and Nearpod.

3.2. Are digital tools gamified? What gamification elements are incorporated into the tools?

According to Dos Santos Carregosa et al. (2019) digital tools, such as Kahoot!, are promising for promoting both student engagement and interactivity in the classroom. Thus, based on the definitions of Werbach and Hunter (2012) presented in Table 4, an analysis was carried out on each tool in free mode, observing what types of gamification elements they present, since the studies do not mention this information.

Table 4 - Gamification Elements by Categories (Werbach and Hunter, 2012).

Categories	Gamification Elements
Dynamics	Constraint, Relationship, Narrative, Progression and Emotions
Mechanics	Feedback, Victory, Resource Acquisition, Turns, Rewards, Cooperation and Competition, Transactions, Luck or Chances
Components	Rewards, Points, Levels, Scoreboard, Avatar, Content Unlocks, Virtual Goods, Badges, Collections, Achievements or Achievements, Social Graph

In general, three mechanical elements, two dynamic elements and four components were found, as shown in Table 5. It was found that all platforms present some type of return, generating the dynamics of emotions.

Table 5 - Gamification elements identified in digital tools.

Gamification Elements		Number of tools in which the elements were identified	
Mechanics	Feedback		100%
	Victory		75%

	Cooperation e Competition	42%
Dynamics	Emoticons	100%
	Progression	50%
Components	Achievements	25%
	Badge	17%
	Leaderboard	25%
	Rewards and Points	67%

The Kahoot!, Wordwall and Quizizz tools use a leaderboard component, which consists of classifying players according to their score. The achievement mechanic was only observed in Quizizz, Quizlet and Nearpod, which still feature a panel, which corresponds to the idea of a badge.

It was found that on average, the victory mechanics, points components, and progression dynamics are present in 63% of digital tools (F1, F2, F3, F4, F6, F7, F8, F10, F12), and that in free mode, none provide elements such as avatars, levels, and virtual goods.

3.3. What types of technologies do these digital tools use to operate?

To answer this question, an analysis of each tool was carried out using W3Techs (2009), a service provided free of charge by Q-Success that collects information about the technologies used in the construction and execution of websites.

The data obtained was organized and classified into applied technologies: Languages for *Frontend*[1], *Backend*[2], Server, Content Management System, Libraries, Rendering Type and Traffic Analysis Tools. The only data not provided by W3Techs refers to the Database. This information was collected using the means of communication provided by the educational tools, with only three responding (F5, F8 and 10).

Regarding the technologies used by educational tools, the graphs illustrated in Figure 3 show that, in Frontend, 83% (F2, F3, F5, F6, F7, F8, F9, F10, F11 and F12) use JavaScript. In the Backend, it was observed that the Ruby language is one of the most used, present in 30% of the tools (F3, F5, F9 and F11), followed by the PHP language, used in 25% (F4, F6 and F10).

[1] Refers to the development of the visual and graphical part of a system [Portela e Queirós, 2018].

[2] Refers to the development of the architecture and structure of a system [Portela e Queirós, 2018].

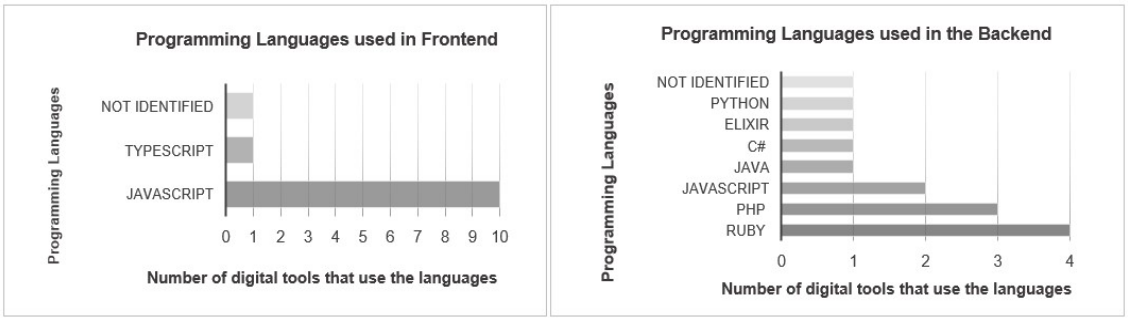

Figure 3 – Programming languages used in the Frontend and Backend of digital tools.

As for the hosting servers used, it is possible to see in Figure 4 that Amazon is the most used by educational tools (F1, F4, F7, F8 and F11). However, in relation to the databases used, there is a significant distribution between technologies, where each educational tool, among those who responded by email, uses a different database. The Padlet tool uses Postgres, Redis, Elasticsearch, Firestore and Snowflake databases. Quizizz uses the MongoDB and Cassandra databases, and LearningApps uses the MYSQL database.

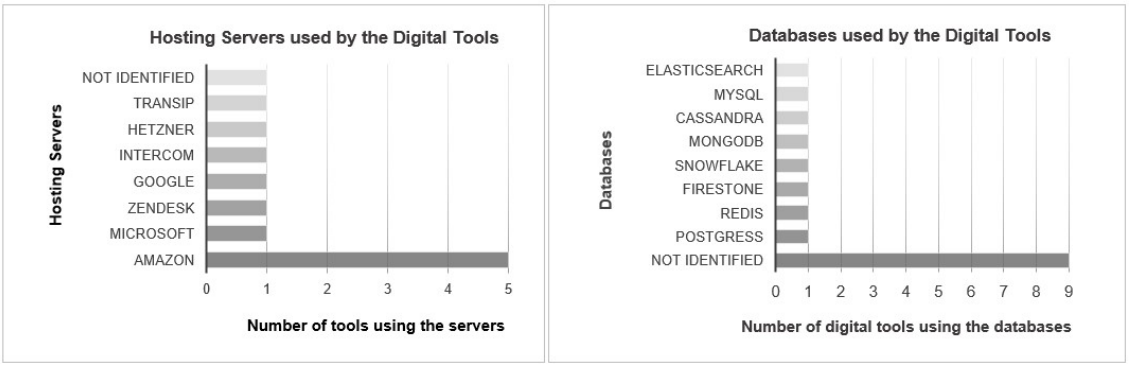

Figure 4 – Hosting and Database Servers used in digital tools.

Figure 5 shows the libraries that were used in the development of the tools, with jQuery being used by 66% of the digital tools (F2, F3, F6, F7, F10, F11, F12). It was also identified that some tools (F3, F4, F6, F7, F8, F11) use Content Managers (GC), which are software that run in the browser to create, manage, and modify a website and its content (Jordan, 2006).

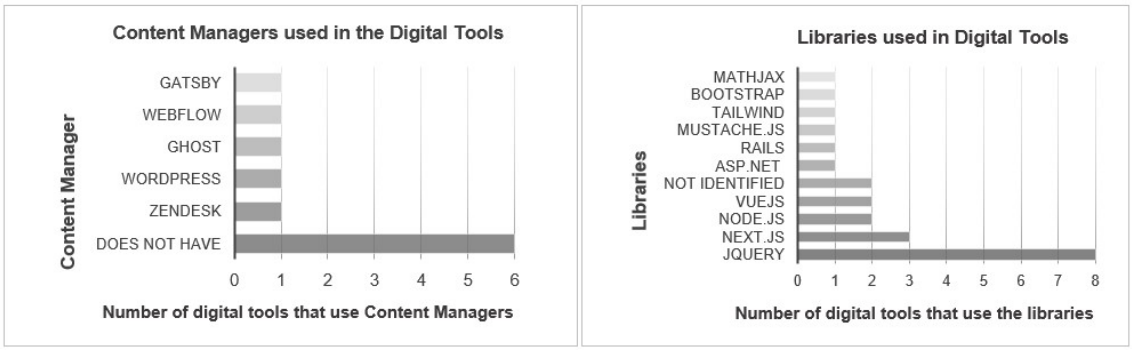

Figure 5 – Content Managers and Libraries identified in digital tools.

Regarding rendering, the use of Server-Side Rendering (SSR) was verified in 58% of the tools (F2, F3, F4, F5, F6, F10, F12). SSR, or Server-Side Rendering, inverts the

rendering process, bringing part of the SPA application rendering effort to the server, in a similar way to traditional loading. Single Page Application (SPA) was found in 42% (F1, F7, F8, F9, F11). The SPA or Single Page Application brings a better user experience through the sensation of navigation between pages much faster. Despite the name, this does not necessarily mean that SPA applications will only have a single page.

4. Trends

Based on the mapping of the technologies used in digital tools, it was possible to observe that the Quiz activity model is an activity format present in 90% of digital tools, a fact that is mainly due to the simple assessment format with immediate feedback. An identified opportunity is to explore other types of activities, such as flash cards, word searches, timelines, and interactive slides.

In relation to gamification, it was observed that elements such as feedback and victory are the elements most used in the tools. The points and progression dynamics could be used more. Avatar components, levels and virtual goods are options that can be considered in the development of new digital tools in a free version, as they are ways to further motivate the student in carrying out activities.

Regarding technologies, it was found that 45% of the programming languages used in the backend and frontend, of educational tools, are among the most used by developers, which, according to research carried out by StackOverflow (2022), are JavaScript, Typescript, HTML/CSS, SQL, Python and PHP. JavaScript stands out here, which is used in 83% of the tools (F2, F3, F5, F6, F7, F8, F9, F10, F11 and F12). According to Taivalsaari and Mikkonen (2007) it is a “surprisingly powerful language and can be used to develop real applications and even system software”.

It is observed that from Education 4.0 there is a trend towards digital tools that cover the use of artificial intelligence, and in this case, the Python language is a strong candidate, since, according to Szymański and Kajdanowicz (2017) its libraries Machine learning has grown to become one of the leading technologies for building models for industry and developing new methods for researchers.

The mapping showed that there is a trend in the use of digital tools to assist educational processes, presenting various resources that can be combined with gamification elements, favoring more meaningful learning for students and more practical assessment for teachers.

5. Conclusion

This article presented a systematic mapping of digital tools that assist the teaching and learning process through interactive resources. The results obtained show that the digital tools are, for the most part, multilingual, have a mobile version and allow, in free mode, the student to access the activity without the need to register an account.

The mapping made it possible to identify the characteristics of the digital tools that have been applied to teaching, characterizing them through interactive resources, gamified elements and types of technologies used. The results show that gamification can be further explored, about elements such as avatars, levels, and virtual goods.

Finally, the study presented information that can be used for the development of new digital tools. As future work, there is a plan to create a digital learning platform incorporating features from free digital tools that cater to diverse audiences, addressing the main identified gaps.

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