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Papers

# New Technologies and the Teaching of Quaternary Geomorphology at the State University of Maranhão – UEMA

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**Abstract**
Technological advances have brought countless changes to the way we see, think, and act in current society. Formal education has faced significant challenges in the face of the various changes related to generational transition of students and the advent of cyberculture. The linear views previously adopted in formal education no longer allow us to comprehend current social phenomena, or to explain the impacts of digital connectivity on society. Therefore, it is imperative that educators continuously adapt and refine their pedagogical strategies to ensure effective knowledge dissemination. This study aims to analyze the use of new educational technologies in the teaching of Quaternary Geomorphology in the undergraduate and graduate Geography courses at the State University of Maranhão. In order to achieve the proposed objective, the research was guided by the following stages: bibliographical survey, choice of educational technologies according to the subjects covered in the discipline, preparation of material for the classes and application of the technologies in the classroom. The main educational technologies used were: Geoguessr, Google Earth, Google Forms, Kahoot, LandscapAR, Nearpod, Virtual Reality Glasses, Padlet, Prezi and Wordwall. The inclusion of new educational technologies in this subject has made it more tangible and practical, with concepts that are close to reality and promote the students' creative process, which has made the subject increasingly interesting. There has been greater student attendance at classes and greater commitment to the activities, as well as real-time assessments and feedback during the online games.



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## INTRODUCTION

Technological advances have brought countless changes to the way we see, think, and act in current society (Sousa; Lima, 2023). Formal education has faced significant challenges in the face of the various changes related to generational transition of students and the advent of cyberculture. The linear views previously adopted in formal education no longer allow us to comprehend current social phenomena, or to explain the impacts of digital connectivity on society (Moran, 2015a; Pacheco *et al.*, 2020; Nascimento, 2021; Melo Neto *et al.*, 2024; Silveira, 2025).

Cyberculture is the interconnected relationship between society, culture, and new microelectronic technologies that emerged in the 1970s (Lemos; Cunha, 2003). Defined as culture, it is essential to discuss and evaluate practical educational processes since it has promoted changes in educational thinking (Jesus; Oliveira, 2020). Strey and Kapitanski (2011) state that society has currently experiencing the pedagogy of the screen, characterized by the inseparability of technology, communication, and education itself.

Thus, digital technologies have advanced as a viable alternative in the teaching-learning process, as "learning with technology" is characterized by concrete activities that encourage students to use technological tools (Costa, 2008). Jonassen (1996) states that learning based on Information and Communication Technologies (ICTs) may introduce relevant cognitive complexity to students through concrete activities that stimulate critical thinking when carrying out tasks or solving difficulties.

New educational technologies, such as virtual learning environments (VLEs), hybrid learning platforms, virtual reality resources, artificial intelligence, and interactive applications gain ground in this scenario, being incorporated into pedagogical practices in primary and secondary education, contributing to the flexibility of teaching, and expanding access to knowledge (Moran, 2015b; Kenski, 2012; Melo Neto *et al.*, 2024; Nascimento, 2021; Silveira, 2025).

The post-COVID-19 pandemic associated with the advent of cyberculture has accelerated the adoption of remote teaching strategies and the use of ICTs. It reveals the potential for the inclusion of computerized education and the challenges of intensive use of innovative technologies (Hodges *et al.*, 2020).

The challenges that permeate the implementation of educational technologies are diverse, from training issues to the infrastructure of the teaching environment.

> Teaching methods and tools used to support learning have undergone significant changes over the years, particularly in the digital age. Technologies have become part of everyday life, even becoming essential, and as a result, teachers and students have had to adapt to these resources. New technologies are essential for accessing information connected to the new teaching environment and for the development of academic learning. However, inserting them into the educational environment demand efforts to adapt and train teachers and students to use them effectively (Sousa; Lima, 2023, p. 58).

> The school structure seldom presents classrooms projected to use educational technologies. The rooms often lack projectors or quality internet connection (cable or wireless). Equipment and connectivity are required along with teacher training and support for the integration of ICTs in the classroom (Venezky; Mulkeen, 2002; Pedro, 2017).

Thus, promoting discussions to reflect on the issues in the academic environment is fundamental to technological educational advancement. The professionals and social beings of the area are trained and may continue to advance on the issues. Therefore, it is essential to encourage reflection on the pedagogical, methodological, and social implications of the use of new technologies, considering their contributions to teaching quality, digital inclusion, and critical development.

Therefore, the present work aims to analyze the use of new educational technologies in the teaching of Quaternary Geomorphology in the Geography courses at the Universidade Estadual do Maranhão (State University of Maranhão) based on the reality of discussions, potentialities and challenges to understand how the use of such tools has impacted the teaching-learning process of students.

## METHODOLOGICAL PATH

Currently, the challenge in teaching is to encourage teachers to seek ways to make lessons more engaging and dynamic (Vieira; Zacharias, 2022). Therefore, involving students in the teaching-learning process in a practical and unconventional way is essential to overcome the challenges of teaching new generations.

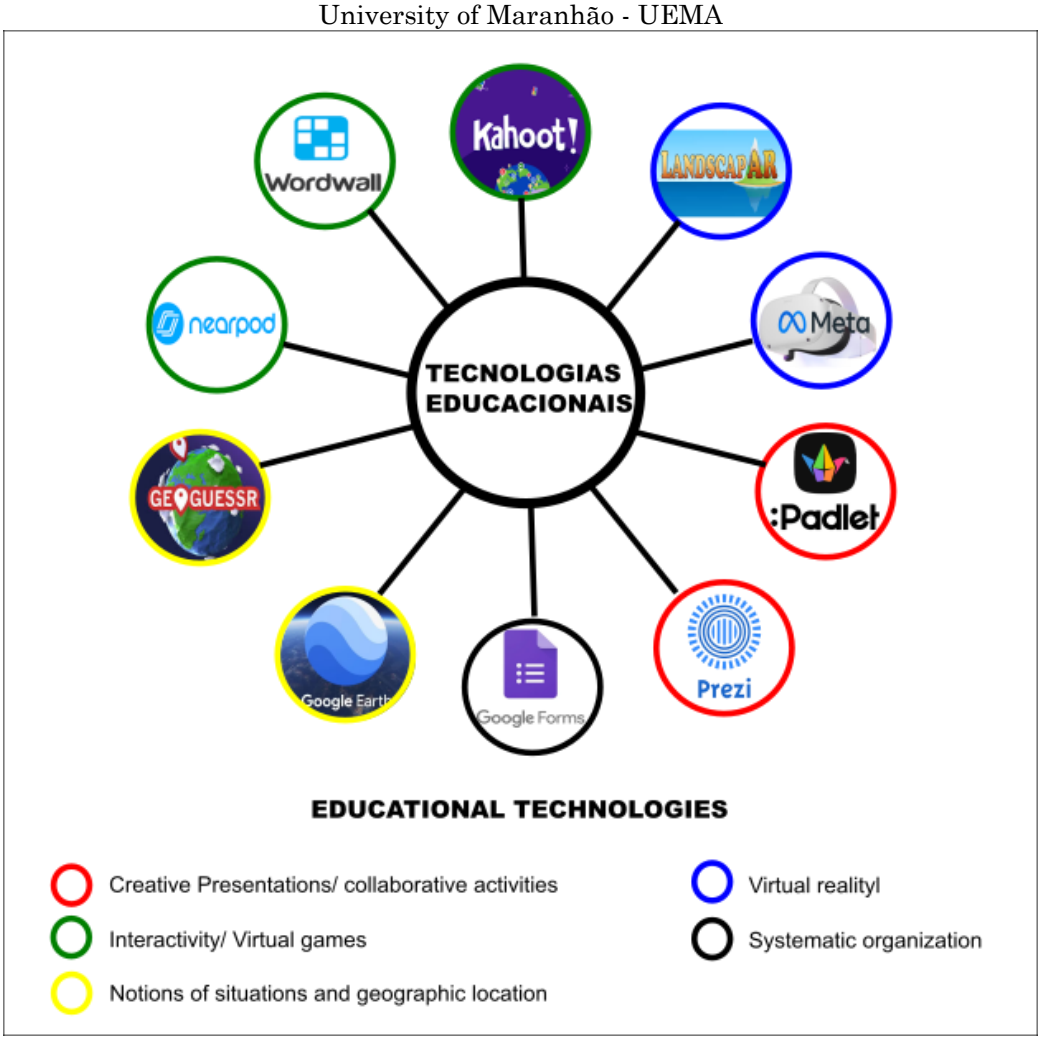
Thus, the methodology applied to achieve the proposed objective is based on descriptive and qualitative approaches, enabling the results and fostering relevant discussions. The methodological steps include bibliographical research, selection of educational technologies based on the topics covered in the course, preparation of class materials, and application of the technologies in class.

At the Universidade Estadual do Maranhão (State University of Maranhão), Quaternary Geomorphology is part of the set of mandatory courses offered in the fourth semester of undergraduate Geography programs. It is assumed that students have acquired the necessary knowledge for the subject. Therefore, classes are designed with focus on reviewing topics, creative introduction of new themes, and practical content retention.

The choice of educational technologies is related to the course syllabus and the teaching planning. In Quaternary Geomorphology at UEMA, the main topics covered are Quaternary Geology, Quaternary Climate Variation, Slope Geomorphology, Fluvial Morphologies, Coastal Morphologies, and Karst Morphologies.

Considering the syllabus, we selected the following learning technologies: Geoguessr, Google Earth, Google Forms, Kahoot, LandscapAR, Nearpod, virtual reality headsets - OCULUS QUEST 2 VR HEADSET SNAPDRAGON XR 256GB, Padlet, Prezi, and Wordwall (Figure 1). The tools were chosen considering the stimuli they may provoke in students regarding creativity, interaction, systematic organization, and the use of smartphones in the classroom as an ally in the teaching-learning process.

Figure 1 - Educational technologies used in the discipline of Quaternary Geomorphology at the State University of Maranhão - UEMA




Source: The authors (2025).

The technologies applied share common purposes and evoked similar stimuli in students. However, for the present study, the specific objectives of each educational tool used in the course were color-coded. In this context, a brief description of each technology is presented, highlighting its main purpose (Chart 1).

**Chart 1** - Description of educational technologies used in the Quaternary Geomorphology discipline at the State University of Maranhão - UEMA

| TECHNOLOGIES | DESCRIPTION / PURPOSE |
|---|---|
| GeoGuess  | GeoGuessr (2013) is considered a simple and straightforward geographic game. The player receives an image of any location in the world and must locate themselves by indicating their location. In the course, the purpose was to offer an interactive and creative learning experience, stimulating principles of location and situation. |
| Google Earth  | Google Earth (2001) is a program for displaying maps and satellite images of the Earth in three dimensions. Widely used for teaching, in business, and everyday situations. The purpose was to assist students visualize and understand geographic, geomorphological, and geoprocessing concepts, making class more practical and interactive. |
| Google Forms  | Google Forms (2008) is a Google online tool that allows elaborating customized forms. It was widespread in schools during the COVID-19 pandemic. In the course, the purpose was to facilitate students access to the content, allowing them to use smartphones, and to provide quick responses. The platform provides spreadsheets and graphs showing the number of students who participated and answered the assessment, optimizing time with instant feedback on the content. |
| Kahoot  | Kahoot! ASA (2013) is a game-based learning platform. Its purpose in the course was to review content, making learning pleasant, interactive, dynamic, and fostering friendly competition among students. The tool reinforces content. |
| LandscapAR  | LandscapAR (2012) is an augmented reality application that allows students to create 3D landscapes from paper contour lines. In the early years of undergraduate studies, students present difficulty interpreting topographic maps. The application assists in geospatial vision promoting notions of spatiality and technical vision, establishing the appropriate cognitive connections between understanding topographic maps, and 3D maps. |
| Nearpod  | Nearpod Inc. (2012) is an online mobile learning tool. Its main purpose was to make thematically personalized classes more interactive and engaging, integrating resources such as videos, polls, and games. |
| Virtual reality glasses (VR) | VR is an immersive device that allows students to access a three-dimensional digital environment through images and sounds, creating sensations similar to reality. In the course, VR was used to provide an experience about different periods of the geological time scale, taking them back to the time when dinosaurs existed, for example. It was applied to other topics, such as karst |

| | |
|---|---|
|  | geomorphology, allowing them to experience sensations related to visiting caves. |
| Padlet  | Padlet Wallwisher PTE. LTD (2008) is an online platform that allows elaborating interactive and collaborative virtual bulletin boards, commonly known in educational settings as mind maps. In the course, it was used in all classes, fostering student creativity in organizing the lesson content. Replacing traditional index cards, students read the material related to the lesson of the day and elaborated mind maps. |
| Prezi  | Prezi Inc. (2009) is an online tool to elaborate presentations. It stands out for its dynamic zoom, rotation, and non-linear structure. In the course, we used it to promote creativity, personalized presentations, visual stimulation, and engaging classroom dynamics. |
| Wordwall  | Wordwall LTD (2012) is an online platform to elaborate digital interactive games and activities. We used it to promote interactive and playful learning through digital activities, such as quizzes, word searches, anagrams, and other games. |

Source: The authors (2025).

## RESULTS AND DISCUSSION

Educational technologies are tools, materials, and processes that seek to facilitate and enhance the teaching and learning process, aiming to empower students in higher education, ensuring the expected level of achievement, facing diverse realities.

In the Geography undergraduate and graduate programs at the Universidade Estadual do Maranhão (State University of Maranhão-UEMA), the Quaternary Geomorphology course has been redesigned and remodeled with regard to the inclusion of new technologies. The course aims to reach students who are part of the generation known as digital natives who experience learning difficulties, due to their overexposure to technology (Tezani, 2017; Pillonetto, 2024). Additionally, they have experienced the COVID-19 pandemic, which has further amplified educational challenges in classroom.

We emphasize that the introduction of new technologies comes to add and support the traditional physical resources, such as whiteboards, books, banners, and other materials, fostering a new perspective.

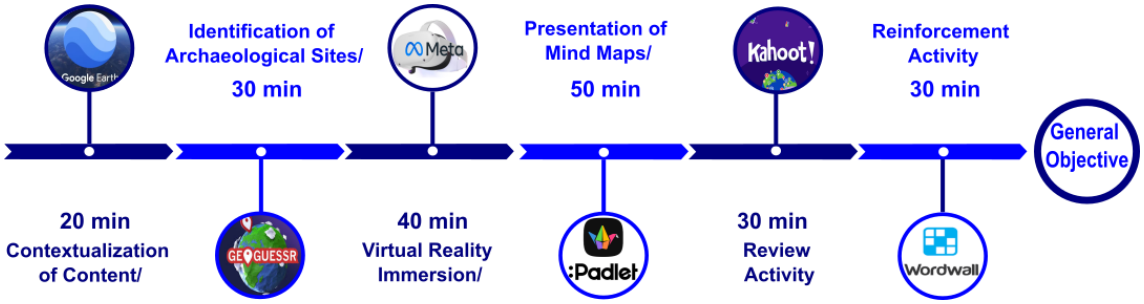
The university offers the course in-person in the morning (Geography Bachelor Degree), and in the evening (Geography Licentiate), totaling 200 minutes in each period. Classes are planned with dynamic and inclusive activities that prioritize the participation of every student in the room (Chart 2 and Figure 2). Students use the applications on their smartphones connected to the University Wi-Fi network.

**Chart 2** – Example of activity planning with educational technologies in the Quaternary Geomorphology discipline

| Content | Educational Technologies | Objective |
|---|---|---|
| Seeking the past of Planet Earth | 1. Google Earth: Contextualizing content using geotechnological tools to observe locations with fossil outcrops in Maranhão;<br>2. GeoGuessr: Identifying paleontological sites in Maranhão;<br>3. VR Glasses: Virtual reality immersion in the Jurassic period assisted by VR YouTube;<br>4. Padlet: Individual presentation of mind maps elaborated in Canva and inserted in Padlet;<br>5. Kahoot: Review activity on the Geological Time Scale;<br>6. Wordwall: consolidation activity with word-hunt about eras and periods of the Geological Time Scale. | Analyze and discuss the main historical events that culminated in the emergence of the Geological Time Scale and the term Quaternary. |

Source: The authors (2025).

Figure 2 - Temporal distribution of activities with Educational Technologies in the Quaternary Geomorphology discipline with the content: Seeking the past of Planet Earth



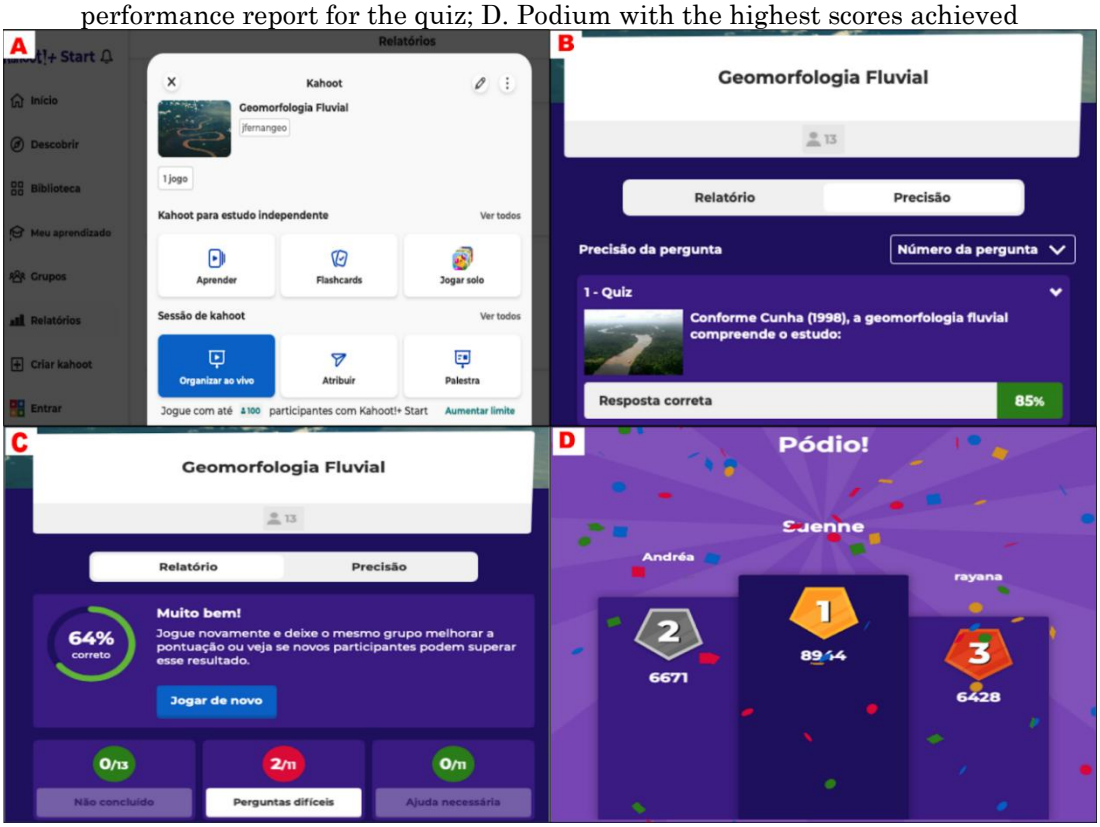

Source: The authors (2025).

We highlight the use of mini thermal printers and Google Image searches of geological records to understand the concepts of eras and periods. Banners with figures and gaps to insert key concepts from the content of Plate Tectonics and Erosion Processes on Slopes is another technique used in the course.

Currently, the Kahoot platform (Figure 3) appears as one of the best-known and widely used educational technologies. The platform offers learning to occur in an interactive and playful way, promoting digital and personal interactions, stimulating intellectual competitiveness, and fostering dynamic review and real-time assessment. Kahoot was used in classes for content review and consolidation exercises. Melo Neto *et al.* (2024) emphasize that the dynamics of teaching and learning process requires a broad view of the classroom, as a place for knowledge acquisition, as well as a dynamic and constantly evolving space of values, behavior, scientific, logical, and participatory thinking. The same authors (2024) consider Kahoot as a technological tool that may

increase engagement, improve content retention, and transform the classroom learning experience.

Figure 3 – Use of Kahoot app in the Quaternary Geomorphology course. A. Selecting the Fluvial Geomorphology activity; B. Quiz interface for content review; C. Sample of individual student performance report for the quiz; D. Podium with the highest scores achieved




Source: The authors (2025).

Computing resources and technological tools represent a powerful way of teaching and learning, encouraging students to acquire knowledge through interactions and encouraging active participation. The application of Google Platform tools in Geomorphology teaching stands out, enabling collaborative learning and knowledge acquisition, as well as real-time interaction and content sharing (Campos *et al.*, 2018).

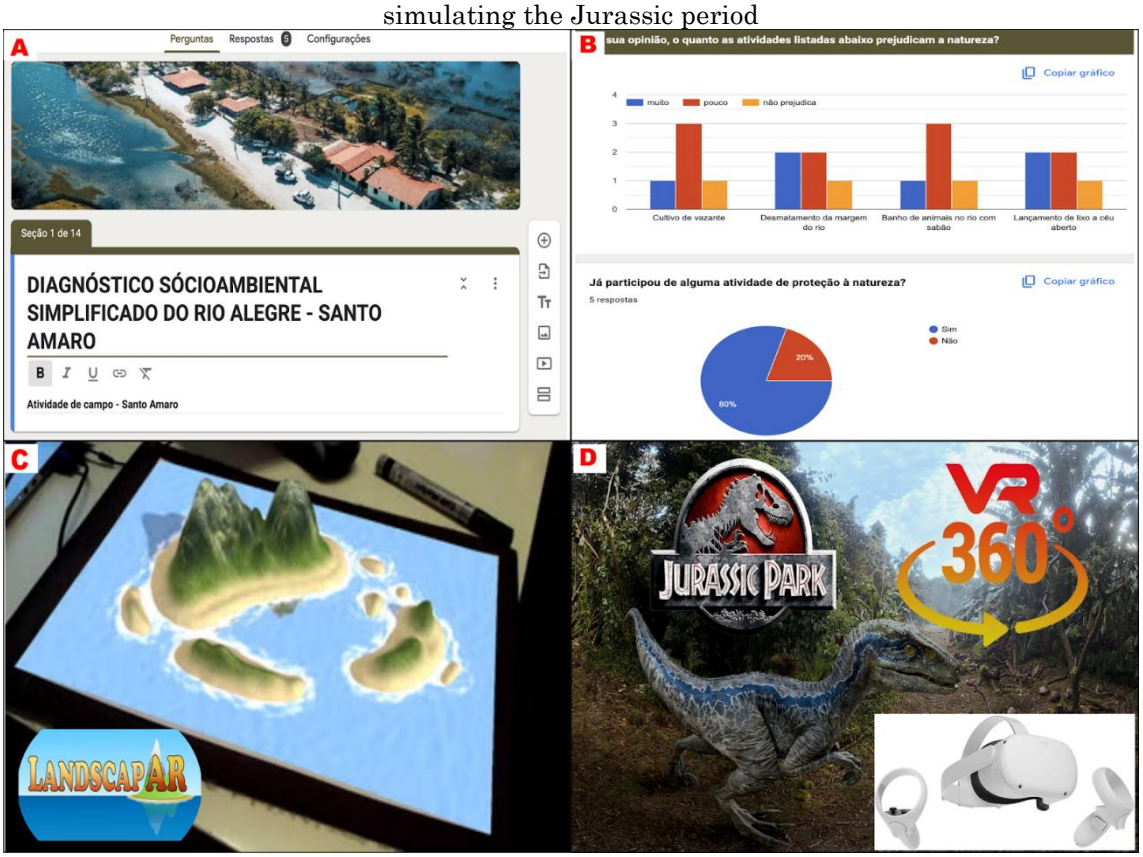
Among the various tools on the Platform, we highlight Google Forms, designed for creating questionnaires for a wide range of purposes, enabling a dynamic and interactive environment. In the classroom or during field activities, questionnaires are applied and responses collected instantly, generating engagement and retention of the content covered (Campos *et al.*, 2018).

According to Gaúna Monteiro and Santos (2020), Google Forms tool allows to elaborate personalized questionnaires and optimizes time during data collection and analysis. The online questionnaires provide support for organized response collection, saving time and improving the conditions for comparative analyses.

Google Forms and its features were used throughout the Quaternary Geomorphology course (Figure 4) aiming to review classroom content and apply a socio-environmental quiz during fieldwork in the municipality of Santo Amaro, Maranhão.

LandscapAR applications and virtual reality (VR) headsets appear as other useful potential technologies with features that foster spatial sensations in students. LandscapAR is an augmented reality application that allows creating three-dimensional landscapes from contour lines. According to Oliveira and Oliveira (2019), and Barboza and Rondini (2020), it provides a pedagogical resource that brings dynamism to teaching and student learning as an ally in teaching routine.

Figure 4 – Using Google Forms, LandscapAr, and Virtual Reality Glasses in the Quaternary Geomorphology course. A: Model of socio-environmental quiz elaborated on Google Forms applied in field activities, analysis and discussion in the classroom in the Quaternary Geomorphology course; B: Result of the application of forms through graphs elaborated on Google Forms; C: Landforms elaborated on virtual reality with LandscapAR; D: Use of Facebook Virtual Reality headsets simulating the Jurassic period




Source: The authors (2025).

Virtual Reality (VR) headsets offer spatial sensations as well as curiosity about geological eras and periods. Students virtually visit periods, such as the Jurassic, witness the evolution of the Earth and its inhabitants. Karst morphologies are also accessed improving their knowledge. According to Ramos and Borges Júnior (2024), the integration of VR devices creates immersive environments in which students may explore complex concepts in a practical and engaging way.

VR devices have become innovative tools in education, transforming the way students learn and teachers teach. By offering students opportunities for new realities, old paradigms have been broken. The applications and devices stimulate curiosity, creativity, and engagement, making the educational process meaningful.

Digital resources, such as Google Earth, allows students to see themselves represented on maps, locating their homes, schools, and neighborhoods, watersheds, and landforms, fostering a sense of belonging and a critical comprehension of the territory. Such geotechnology is taken as a pedagogical mediation tool to bring students closer to their living space, enabling dynamic and contextualized interpretations of reality (Silveira, 2025).

By implementing Google Earth application in the Quaternary Geomorphology course, the exploration of several landscape units with diverse morphologies at different scales of analysis, such as the dune system of Parque Nacional dos Lençóis Maranhenses (Lençóis Maranhenses National Park), and the riverbed of the Alegre River in Santo Amaro, Maranhão (Figure 5).

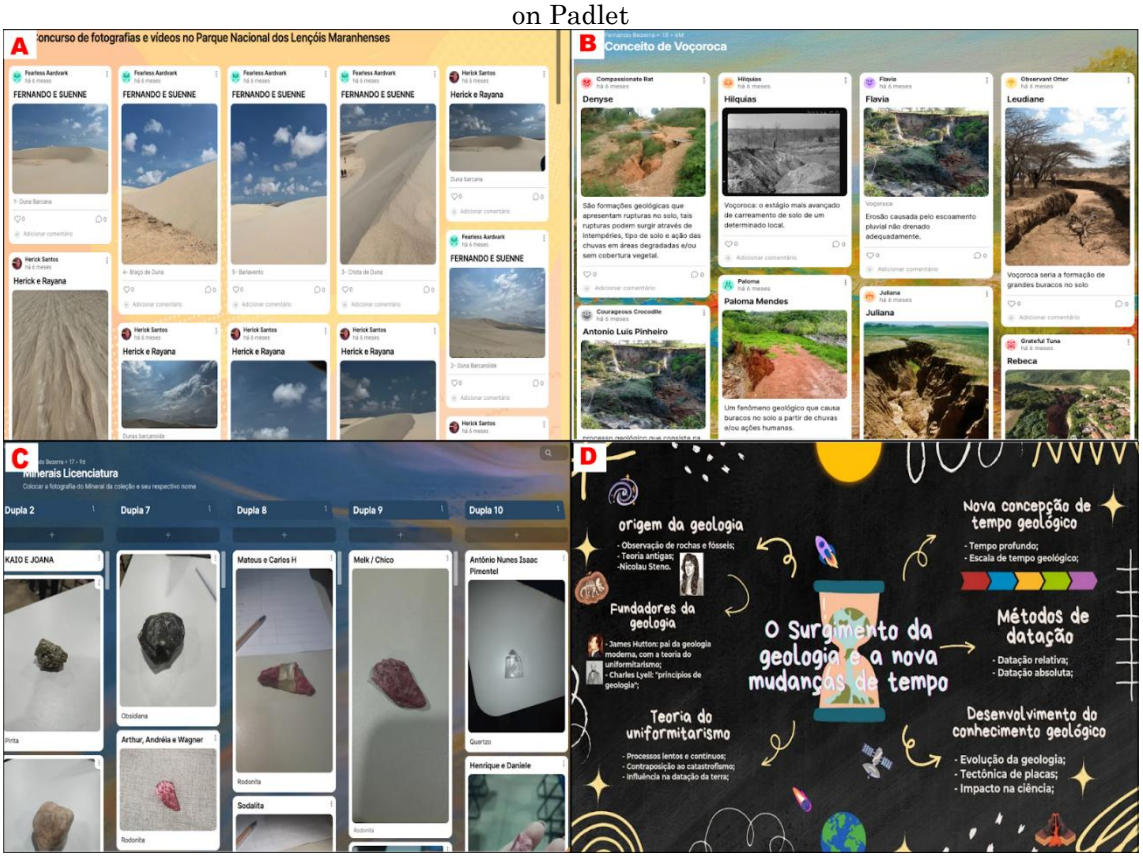
Prezi is a personalized, dynamic, and engaging presentation tool that allows non-linear navigation with zoom and rotation options for content exploration. Prezi stands out from conventional presentations once it streamlines content, stimulates audience interest and participation, as well as enhances communication skills. It promotes the visual organization of complex concepts, increases student-professor engagement, and boosts memory. It may be used for presentations and to elaborate mind maps.

Figure 5 - Google Earth and Prezi. A: Comprehending the main characteristics of Lençóis Maranhenses using Google Earth; B: Anastomotic drainage pattern of Alegre River, Santo Amaro do Maranhão; C and D: Dynamic presentations using Prezi


Source: The authors (2025).

Students pre-read the available bibliographic material related to a certain topic, and prepare a mind map on Padlet. The tool allows sharing materials, stimulates creativity, enables active learning, and records the learning process. Mind maps keep saved in the virtual environment, generating an extensive database. An example, students elaborate a mind map about the emergence of geology and the new time shift on Canva PTY LTD (2012) to contextualize and comprehend the term Quaternary (Figure 6).

Figure 6 - Using Padlet app in the classroom – A: Photography contest of the dune morphologies of the Lençóis Maranhenses National Park; B: Presentation of concepts based on gullies and their representations; C: Identification of mineral types; D: Mind map elaborated on Canva and presented on Padlet




Source: The authors (2025).

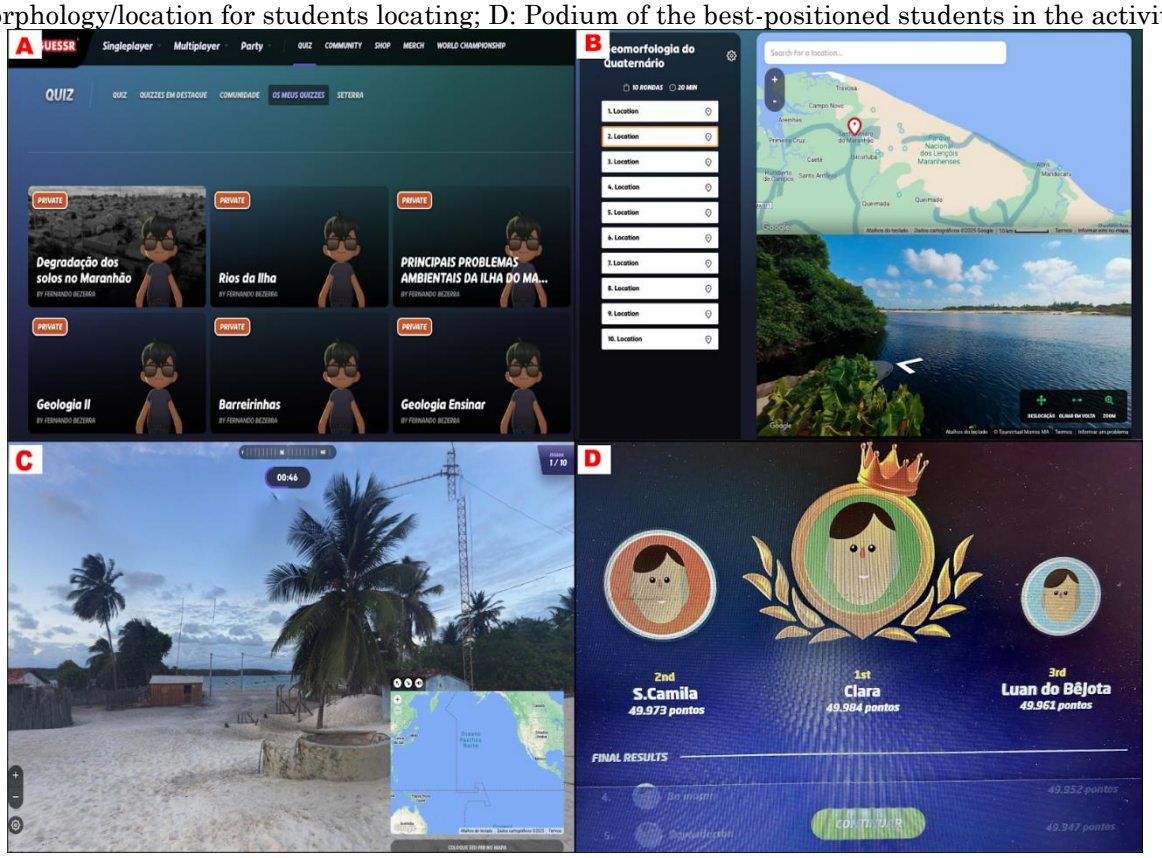
Reviewing content is essential for long-term learning. According to Andrade (2015), it allows identifying gaps, reinforcing content, and provides linguistic development. Therefore, the lesson begins with a brief review of the content covered previously, seeking to consolidate it and to assess the learning process. Depending on the topic covered, the review may occur in a traditional expository format or through technology.

GeoGuessr was used as a geolocation tool to enhance students' sense of location and situation. The tool stimulates critical thinking, expanding interest in learning about new places, cultures, and develops a sense of geographic location. It offers a pleasant and creative way of teaching, stimulates logical reasoning and spatial orientation, and enhances basic cartographic language. By using the platform, students performed activities related to the location of landforms in Maranhão (Figure 7).

Gamification is a common practice in the use of educational technologies. It aims to promote systematic and meaningful learning by stimulating logical reasoning and interrelationships among students. In addition, it enables thoughtful and creative individuals to perform solutions facing problems presented. Gamification provides a dynamic and adaptable learning environment, where students learn at their own pace, strengthening their confidence, and transforming the learning process into a pleasant experience (Melo Neto *et al.*, 2024).

Thus, Nearpod and Wordwall platforms offer educational technology resources to facilitate dynamic and meaningful learning in the Quaternary Geomorphology discipline (Figure 8).

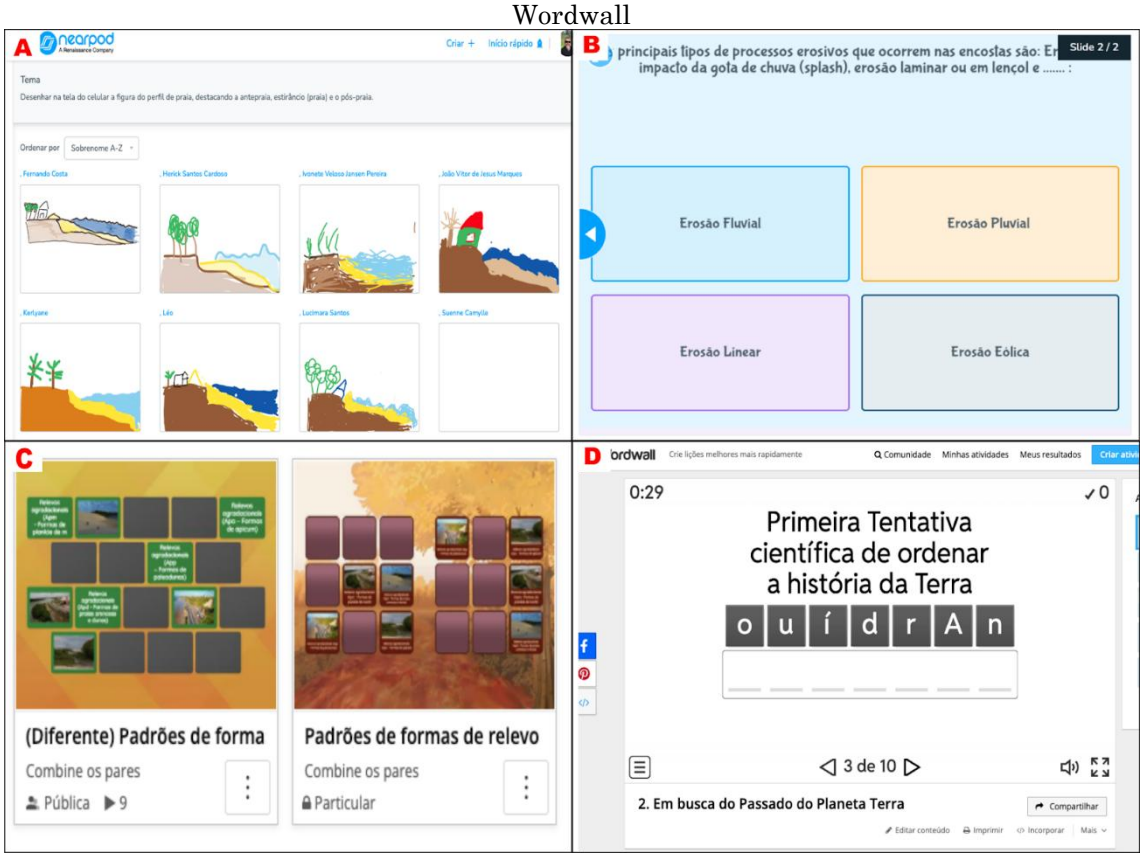
Figure 7 - Google Earth location platform – A: Examples of activities that used in the geomorphology course; B: Map layout and photograph for classroom activity; C: Photograph of a known morphology/location for students locating; D: Podium of the best-positioned students in the activity




Source: The authors (2025).

The introduction of new educational technologies in the discipline of Quaternary Geomorphology has improved students' engagement and performance in learning. Moreover, we observed that the use of digital technologies in the class provides a healthy environment, as smartphones become a teaching ally rather than a competitor for the teacher. Thus, a summary of the tools used in the course is presented (Chart 3).

Figure 8 - Nearpod and Wordwall app interface – A: Building a beach profile on a cell phone screen with the Nearpod; B: Review questions on Climb the Mountain in Nearpod; C: Identifying landform patterns on Maranhão Island on Wordwall; D: Reviewing the history of Quaternary geology with Wordwall




Source: The authors (2025).

**Chart** 3 - Summary of instruments used in Quaternary Geomorphology classes

| Nº | EDUCATIONAL TECHNOLOGY / TOOLS USED | ACTIVITY |
|---|---|---|
| | Banners | Identifying river, coastal, and slope morphologies. |
| | Documentaries | Videos related to the day's class. |
| | *Funprint* | Portable printers used to elaborate posters. |
| | GeoGuessr | Platform used for geographic location activities. |
| | Everyday geomorphology | Presentation of work in pairs. Each pair chooses a topic from their daily lives related to Quaternary geomorphology and present it. |
| | Google Earth | Platform used for geographic location activities. |
| | Google Forms | Development of activities. |
| | Kahoot | Quiz games with scores. |
| | LandscapAR | Relief analysis. |
| | Portable Digital Microscope | Analysis of Quaternary sediments. |
| | Nearpod | Time to Climb and Draw It games. |
| | (VR) Virtual reality headsets | Immersion in the geological history of the Earth and coastal morphologies. |
| | Padlet | Elaboration of mind maps with prizes for the 3 top voted by the class. |
| | Graph paper | Elaboration of flow profile. |
| | Tracing paper | Drawing Milankovitch cycles. |
| | Prezi | Presentation of classes. |
| | Fieldwork | Trip to municipalities with emphasis on coastal and river geomorphological processes in Maranhão. |
| | Printed texts | A3 and A4 material with questions for reflection and response development. |
| | Wordwall | Memory games, word hunt, association games, etc. |

Source: The authors (2025).

## CONCLUSIONS

The use of new educational technologies in higher education has fostered diverse and significant changes in pedagogical practices, promoting interactive, dynamic, creative, and student-centered learning. The use of apps, platforms, and devices has become increasingly intense since the pandemic, when the whole educational system was reconfigured to meet the specific demands.

In higher education the aim is to bring flexibility, personalized activities, and integrative education beyond its walls, considering the digital-native generation.

In recent years, Geography undergraduate and graduate programs at the Universidade Estadual do Maranhão (State University of Maranhão) have experienced an innovative way of teaching and learning through initiative of the Quaternary Geomorphology instructor. The introduction of digital educational technologies in the course has made it tangible and practical, bringing concepts closer to reality and fostering students' creative processes. Thus, the course has become significantly engaging, as evidenced by the attendance and engagement of students with activities, as well as real-time assessments and feedback during online games.

The relevance of incorporating digital technologies to the course aims to enhance students' ability to visualize complex geomorphological processes, bring theory close to practice, expand knowledge of geospatial content, and activate a teaching-learning process aligned with the reality of their generation.

However, it's worth noting that, although the potential of educational technologies is widely recognized in a wide range of fields, the effectiveness is straightly related to factors such as professor training, professional development, and structural and strategic educational management. Therefore, discussing the topic becomes essential to evolve, involve, and expand widely to several programs, campuses, and universities.

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