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Who Wants to Be a Geomorphologist? Gamification in a BSc Teaching Course

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Abstract: Despite the importance of Earth sciences in addressing the global challenges that humanity is presently facing, attention toward related disciplines has been witnessed to be globally declining at various levels, including education and university teaching. To increase students' engagement and explore alternative teaching activities, a didactical experiment was carried out at the University of Florence (Italy); the teaching course, "basic elements of geomorphology", was reorganized to include relevant elements of gamification. Parallel to the frontal lessons, a competition based on a recurring quiz game was conducted. This activity was called "Who wants to be a Geomorphologist?", clearly paraphrasing a notorious TV show. During every lesson, a moment was included where the students used their mobile devices to access a series of quizzes that were previously prepared by the teacher to test the reasoning skills of the students and their abilities to make connections between distinct topics. A commercial educational app was used to organize the activity, run the quiz sessions, assign points, and update the leaderboard in real time. A quantitative evaluation procedure assessed the positive impacts in terms of supporting the learning process, improving the engagement in the teaching course, and fostering the liking for geomorphology.

Keywords: gamification; geomorphology; teaching; serious game; Earth sciences; geoscience

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1. Introduction

Earth sciences (including geology and geomorphology) are of paramount importance to address some of the most urgent global challenges that humanity is currently facing. They are the keys to understanding climate change drivers, impacts, and mitigation strategies [1,2]; they are needed to build societies that are resilient to natural hazards [3,4]; they have deep interconnections with most of the United Nations' Sustainable Development Goals (SDGs) [5,6]; and they are fundamental for the exploitation and management of natural resources [7,8]. Despite that, the attention to these disciplines has been witnessed to be globally declining at various levels, including in education and university teaching, and a vicious circle has been set up from governmental levels that support policies undermining Earth sciences to youngsters who do not perceive the importance of Earth science-related disciplines or even ignore their existence [1,9].

This background explains the urgency to find alternative means to raise the awareness of Earth sciences and geomorphology and to increase the engagement of students of all levels [10]. In this regard, gamification is reportedly a promising approach; gamification can generally be defined as the addition of game-related elements to activities of any kind [11,12], and it has recently gained popularity in teaching and dissemination activities [13–15]. In these fields, the term "serious games" is also widely used, addressing games in which amusement is not the primary objective [16], as the game is conceived, for example, to gain awareness about a certain problem [17], to train some skills [18], to foster critical thinking [19–22], or for teaching purposes [14,23]. In particular, some recent review works reported a growing use of digital "student response systems", highlighting the positive impacts that they may have on students in terms of motivation and results [24,25].

However, in geosciences, and in particular, in geomorphology, the use of gamification seems marginal, as only a few examples can be found in the international scientific literature, mainly related to very specific applications such as sustainability or geological hazards [26]. For instance, Hazagora is a board game focused on geohazards (e.g., earthquakes and volcanic processes), targeting secondary school students, citizens, and stakeholders [17]. It was proven to be a valid tool to foster the understanding of geohazard mechanisms, the possible spatial extent of their impacts, societal vulnerability, and the importance of mitigation measures [17]. Another good example is "Cranky uncle", a textual game developed in a mobile app that uses humor and psychological elements to contrast misinformation about climate change [20]. Concerning university teaching activities, even fewer examples are available. For instance, ANYCaRE is a tabletop role-playing game used to enhance the awareness of complexities and uncertainty in forecasting and managing weather-related hydrogeological disasters [27]; it was originally designed to increase the mutual connections between researchers and forecasters of different fields, but recently, it was also adapted to undergraduate university students. Recently, Segoni [28] introduced a live session of a role-playing game in a master's degree course of "geological elements for environmental impact assessment" and documented positive feedback from the students concerning engagement, teaching potential, and amusement. Hasan and co-authors [14] introduced gamification elements by assigning points to group activities carried out in a geosciences course for a master's degree in petroleum engineering. Sustainable City is a cardboard game that was used to make students understand that geoscience is the key to approaching all environmental issues, with deep connections with SDGs [29].

On the trail of these activities, to increase the engagement of students and to explore alternative teaching approaches, a didactical experiment was carried out at the University of Florence (Italy); the module "Basic elements of geomorphology" (included within the compulsory courses held during the first years of the bachelor's degrees "Civil Engineering" and "Environmental Engineering") was reorganized to include relevant elements of gamification. This manuscript reports on the details of the gamification process and presents a brief quantitative evaluation procedure aimed at assessing the impacts that the activity had on the students in improving their engagement toward the teaching course and geomorphology in general.

2. Materials and Methods

2.1. Features of the Teaching Course

The subject of this study is the teaching module, "Elements of geomorphology" (27 h), held during the academic year of 2022–2023, which constitutes half of the teaching course, "Elements of geology and geomorphology" (54 h), a compulsory teaching course scheduled during the first years of the bachelor's degrees "Civil Engineering" and "Environmental Engineering" at the University of Florence (UNIFI henceforth). The topics covered by the "Elements of geomorphology" module are very basic concepts of geomorphology and physical geography, including a quick overview of the main processes and landforms typical of Italy (erosion and mass movements, fluvial geomorphology, coastal geomorphology, glacial geomorphology, karst geomorphology, and structural geomorphology). Like every other teaching course in the Italian university system, the final mark is expressed in thirtieths (with 18/30 being the minimum requested to pass the examination and 30/30, cum laude, being the maximum). During the academic year analyzed, 111 students were registered in the course. The course was held only in "live" mode, and classes were held twice a week from September to December 2022. Attendance was not compulsory in this course, and only approximately 25 students regularly frequented the classes (attending students), approximately 50 students attended about half of the lessons (occasional attending students), and the others never attended (non-attending students). Typically, during every class, the number of students ranged from approximately 30 to 40.

2.2. Gamification of the Didactical Activity

According to the specifications of UNIFI, the teaching course was organized using Moodle™ (https://moodle.org/, last accessed on 7 October 2023), an open-source learning platform that is mainly used as a repository for didactical material and allows students and teachers to interact with messages and forums. The gamification was based on "Wooclap", a students' response system app that is integrated as a plugin on the Moodle platform. Wooclap was first introduced at UNIFI during the COVID-19 pandemic, when lessons had to be delivered in hybrid or virtual mode according to the restrictions of the time. Since it was positively evaluated by students and teachers [30], it was kept available even after the end of the sanitary emergency.

By means of Wooclap, a series of quizzes (at least two questions for each broad topic covered in the program) was created. The questions were typically structured as "multiple choice" or "one among many" answers. Sometimes, the questions integrated a figure, and students were asked to recognize landforms and active processes or to provide an interpretation. Other questions asked whether (and in which way, e.g., positive or negative feedback) two processes/features could be related to each other. Supplementary File S1 provides an exemplification of some questions, together with short notes explaining the didactical objectives of each quiz.

All quizzes were prepared in advance and stored in Moodle. In the implementation chosen, the quiz could be opened and closed at will by the teacher, without pre-defined timings. This allowed for the maximum possible flexibility; the teacher navigated the Wooclap tool to launch the quiz of the day, the students accessed the quiz with their mobile phones/tablets using a QR code, logged in with their student IDs, visualized the activity selected by the teacher, and provided an answer. Every time the teacher stopped a session, the system automatically checked the answers, showed which were wrong and which were correct (along with the numbers of answers received for each option), and assigned points for every correct answer. Because of the ID login, the system in the background tracked the answers provided by each student in different lessons and automatically updated the leaderboard.

2.3. Schedule of the Activity

From the first lesson of the course, the "Who wants to be a geomorphologist?" activity was introduced to the students as a serial game, and it was made clear that at the end of the course that the students in the highest ranks of the final leaderboard would receive a bonus to be applied to their mark during their final examinations. The bonus ranged from +3 points for the winner to +0.5 points for the students who ranked 11th to 15th.

Each lesson had a dedicated time (typically 10–15 min) to deliver a quiz to the students. Typically, this amount of time was used to deliver two or three questions and to explain why each answer was wrong or right. The teacher also fostered a discussion about errors, misunderstandings, or misconceptions. After that, the "Who wants to be a geomorphologist?" activity was concluded, showing the updated leaderboard. At the beginning of each lesson, the teacher again showed the top three, top ten, and top fifteen leaderboards to the students; this "ritual" was an indirect invitation for the students to follow the lesson carefully (any topic could be a potential subject for the next quizzes), and to try their best to improve their rankings.

2.4. Evaluation Questionnaire

At the end of the course, the teacher sent the students an email with a link to an electronic form, in which the students were asked to evaluate the activity by answering the following questions:

- Did the activity improve your engagement with the course?
- Did the activity foster your willingness to attend in person?
- Did the presence of a prize (bonus points in the final examination mark) contribute to the activity's appeal?

- Did the activity improve your liking for geomorphology?
- How useful was the activity from a didactical point of view?
- How funny did you consider the didactical activity?
- Would you recommend the teacher to repeat it the next year?

The answers were based on an evaluation score ranging from 1 to 5 (1 = very negative, 2 = negative, 3 = intermediate/neutral, 4 = positive, and 5 = very positive). Moreover, two additional questions were included in the questionnaire:

- Do you have any additional comments? (open answer)
- Do you give your consent to use the answers provided? (yes/no)

3. Results

Overall, the "Who wants to be a geomorphologist?" activity was well received by the students, as all of the attendees who regularly or occasionally attended the lessons participated in the activity. This also included the discussion session at the end of the game; the students were generally interested in understanding the errors, and most of them participated actively.

Twenty-six students completed the questionnaire and provided consent to use their answers for analysis and publication. No additional comments were provided in the open text box. The results of the questionnaire were generally positive and helped highlight the strengths of the gamified activity and the points with further perspectives of improvement (Table 1).

Table 1. Results of the questionnaire.

	Absolutely Not	No	Neutral-Indifferent	Yes	Yes, Very Much
Did the game improve your engagement with the course?	-	-	-	14	12
Did the game foster your willingness to attend the lessons?	-	-	3	13	10
Did the presence of a prize (bonus points in the final examination mark) contribute to the activity's appeal?	-	1	4	12	9
Did the activity improve your liking for geomorphology?	-	-	5	7	14
Was the activity useful from a didactical point of view?	-	-	-	16	10
Do you think the didactical activity was amusing?	-	1	3	6	16
Would you recommend that the teacher repeat it the next year?	-	1	-	9	16

The students declared that the activity improved their engagement in the course (very much = 12; yes = 14; no neutral, negative, or very negative answers), fostered their willingness to attend the lessons in person (very much = 10; yes = 13; 3 neutral answers; no negative or very negative answers). In particular, most of them acknowledged that a significant driver was the presence of a prize consisting of a bonus to obtain a higher mark in the final examination (very much = 9; yes = 12; 4 neutral answers; no = 1; no very negative answers). Indeed, the percentage of students who attended the lessons in person was higher than that in the previous year (the comparison cannot be extended further due to COVID-19 pandemic restrictions).

The students also declared that the game was useful from a didactical point of view (very much = 10; yes = 16; no neutral, negative, or very negative answers) and, at the same

time, declared that it was amusing (very much = 16; yes = 6; 3 neutral answers; 1 negative answer; no very negative answers). Focusing outside of the teaching course and widening the attention of the students regarding geomorphology in general, most of the students declared that the activity contributed to increasing their appreciation for this discipline (7 = very much; 14 = yes; 5 neutral answers; no negative or very negative answers).

Last, as a final indicator of the positive outcome of this experimental activity, it should be noted that most of the students declared to be satisfied and recommended (9 answers) or strongly recommended (16 answers) to repeat the "Who wants to be a geomorphologist" game in the following year (one negative answer was received without any further comments or motivation).

4. Discussion

As noted in [14], normally, a basic course on geomorphology is not attractive for engineering students, as the subject is treated from a qualitative point of view, requires memorization, and lacks relevant calculation elements. The feedback received from the students allows to assess that the adopted gamification elements increased the engagement of the students in the teaching course and in geomorphology in general. As a consequence, the "Who wants to be a geomorphologist?" activity will be repeated during the next academic years, incorporating the lessons learned during this experiment.

For instance, the schedule of the activity described in the previous sections is the final result of several adjustments that occurred during the semester, based on the feedback explicitly or implicitly received by the students. The "ritual" of showing the general ranking at the beginning of each lesson was introduced later during the course after repeated requests were made by some students. Similarly, at the beginning of the course, there was not a standardized moment for the activity; sometimes, it was held in the middle of the lesson (immediately after the topic of interest), sometimes at the beginning (to activate pre-knowledge) and sometimes at the end (in case the questions were conceived to develop logical connections between the main topics that were covered that day). However, it was verified that introducing a standardized "game time" at the end of the lesson was more effective for many reasons. First, when the game was held in the middle of the lesson, it disrupted the flow of the lesson itself. Second, it was observed that immediately after the quiz, the students typically asked for a break before continuing the lesson, leading to a consistent loss of time. The quiz is not a stressful or demanding didactical activity, but it cannot substitute a real break in which the students can stand up, leave the classroom, have some refreshments, and so on. After a few weeks, the quiz was regularly delivered at the end of the lessons, and the feedback from the students was positive. One of the most important factors was that the students knew that there was no urgency to start the "real" lesson again, so they were more willing to interact with the teacher, asking for additional information and sometimes also starting small interactive discussions.

This study does not aim to demonstrate that the gamification activity has an impact on the final marks of the students (the differences in the final marks obtained by the students in the academic years of 2021–2022 and 2022–2023 are not statistically significant). However, the following example showcases that one or two quizzes at the end of each lesson can be effectively used to fix some key concepts. In geomorphology, the process of thermoclastism can be considered a relatively simple one; it is a process of the mechanical weathering of rocks induced by frequent thermal excursions. Repeated relevant variations of temperature cause the dilatation and contraction of the single minerals, and those alterations, in turn, weaken and progressively disaggregate the rock. Since the process is driven by thermal excursions, it follows that it is the least intense in climates where the temperature is relatively constant, while it is the most intense where the climate is characterized by frequent thermal excursions. During the previous year, this was clearly explained during the lesson (both verbally and written in the projected slides). However, during the final examination, the question of "what is thermoclastism and in which circumstances it is more intense?" usually received a response that was not fully satisfactory. During the

gamification of the teaching course, a question about thermoclastism and climate features was included in the quiz (and received 96% correct answers). During the final examinations, the same question of "what is thermoclastism and in which circumstances it is more intense?" was proposed. In contrast with the outcomes of the previous year, all students participating in the game provided a correct response. This example shows that the reasoning triggered by a game can reach a bigger impact on the students' knowledge than simply explaining a concept during a class and reporting it in the didactic material.

The term "serious game" seems appropriate for the activity proposed, as despite the presence of elements of amusement, the students took the activity very seriously. This is confirmed by the responses obtained to some questions that were purposely structured to check if the ludicrous aspect of the activity was putting the serious and didactical aspects at stake. In some multiple choice questions, the options that were provided as possible answers were the right answer, a wrong (but possible) answer, and a funny and clearly wrong answer. The students smiled and laughed while reading the third option, but ultimately, nobody selected the funny but clearly wrong answer, showing seriousness and commitment to the activity.

The correct attitude of the students is also fostered by the opportunity to obtain scores that could eventually lead to a bonus on the final mark; indeed, the presence of a competition and a reward was another fundamental requisite for the success of the activity. This is in accordance with most of the literature concerning serious games [31,32] and is clearly confirmed by the answers to the evaluation questionnaire.

Indeed, it is worth noting that during the first sessions of the game, some students were reluctant to participate because they were afraid of not being as prepared as they would be for an intermediate or final examination. They complained, "I have not studied yet" or "I didn't attend the previous lessons". This point is critical and was clearly addressed by the teacher from the beginning of the design of the activity; the questions of the quiz were conceived to foster critical thinking in the students, and they were never mere checks of the understanding or memorization of the lesson. In other words, it was not necessary to have studied. When the students were made aware of this approach, they were more relaxed and willing to participate, and they had one more reason to follow the next lessons with attention. Moreover, the occasional attending students were also engaged in the activity. Indeed, the evaluation of the activity by the students does not change significantly according to their positions on the leaderboard or the number of sessions attended. This approach also had two fundamental implications: (i) it prevented students with low positions on the leaderboard from losing interest in the activity, and (ii) it helped them to perceive the "Who wants to be a geomorphologist?" activity as different from a standardized evaluation test.

This perception was further enhanced by another feature. Indeed, it should be noted that "delivering" an evaluation test as a game demands a deep involvement of the teacher; as the success of a TV show depends both on the format and on the presenter, similarly, the gamified activity required the teacher to act consequently, temporarily turning the class into an informal environment, creating excitement around the leaderboard update, delivering jokes ("you are free to talk each other, and you are free to suggest the answers to your mates. . . of course the wrong one: this a competition after all!"), commenting on the outcomes in a funny way, and fostering an informal discussion where the students could be more willing to participate actively. Paradoxically, the setup of this "environment" represents the biggest difference between the gamified activity and a standard evaluation test, rather than the mechanic of the game, which is based on questions, answers, and scores.

5. Conclusions

"Who wants to be a geomorphologist?" is a gamified teaching activity introduced in the course, "Basic elements of geomorphology", which is a compulsory course of the bachelor's degrees "Civil Engineering" and "Environmental Engineering" at the University

of Florence (Italy). This activity consisted of a serial competitive quiz game that took place at the end of each lesson; during each "episode", some questions were delivered to the students, who answered by using an app that allowed for the statistics on the answers provided to be shown (thus fostering a discussion with the teacher), allowed for points to be assigned, and allowed for a leaderboard to be updated. At the end of the course, the students in the first ranks received a prize consisting of bonus points for their final marks.

When asked to express feedback on this gamified activity, the students declared that the experience was positive from many points of view: it was fun and instructive; at the same time, it improved their engagement with the course and the subject matter (geomorphology); and overall, they advised that the activity be repeated again in the next academic years.

It is important to stress that basically, the "Who wants to be a geomorphologist?" activity consists of a written test (with close answers), delayed in several parts, with a possible impact on the students' final marks. When seen from this perspective, it is not much different from a series of "standard" intermediate evaluation tests. Instead, "Who wants to be a geomorphologist?" was perceived as a radically different (and definitely more amusing) activity; this perception was key to its success among the students and was obtained mainly in two ways: (i) by designing the questions to foster critical thinking rather than to check the knowledge or the memorization of concepts (with the additional benefit of giving both the attending students and occasional attending students the same level of chances) and (ii) through a small dose of role playing by the teacher, who delivered the activity in an informal and funny environment, similar to a TV show.

The fact that these tests were delivered as a ludicrous activity obtained a much more positive impact on the engagement of the students and the liking for the activity, thus strengthening the idea that gamification has a very wide potential to increase the commitment of youngsters toward Earth sciences and related subdisciplines such as geomorphology.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/geosciences13110322/s1, Supplementary File S1 provides an exemplification of some questions, together with short notes explaining the didactical objectives of each quiz.

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