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Article

# Transmedia in Geosciences Education

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**Abstract:** This paper describes a research study related to the development (conception, production, implementation and evaluation) of a set of transmedia activities associated with the study of humans 'use of rocks. To do so, a narrative was created to guide students through a set of tasks—namely, during and after a field trip. During this field trip, students had to macroscopically identify a rock sample and record its geographical location, as well as take pictures in six stations. According to the data collected, students would, after the field trip, share this knowledge in a digital learning environment and collect pieces of a puzzle and, in some cases, badges. These transmedia activities, in line with the STS (Science-Technology-Society) perspective, aimed at contributing to the diversification of educational resources for Geosciences education. The study, predominantly qualitative in nature, reached 104 students from the 7th and 5th grades in a Natural Sciences course and the analysis of data suggests that students showed some skills in areas such as "interpersonal relationships", "scientific, technical, and technological knowledge" and "information and communication", although in this case they can be considered rather limited.

**Keywords:** transmedia; geosciences education; STS (Science-Technology-Society); digital technologies



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## 1. Introduction

The research study presented in this article intended to develop and evaluate the impact of a set of transmedia activities aimed at the study of one of the recommended themes in the Natural Sciences course of the 5th and 7th grades of basic education in Portugal [1,2]. The transmedia activities refer to the study of the use of rocks in everyday life. This theme was selected since it is part of the documents of *Aprendizagens Essenciais* (Essential Learning) [1,2] in the Natural Sciences course of Portuguese basic instruction, which includes the 5th and 7th grades. Moreover, in Portugal, recent educational reforms emphasize the development of knowledge, capacities, attitudes and values that contribute to students' social and personal development. In science, it is important not only to have scientific knowledge but also be able to use it in decision making in themes that involve science and society.

The development of the activities was based on the application of transmedia storytelling and the Science-Technology-Society (STS) perspective. Considering the prevalence of the school textbook in Portuguese basic education [3], this approach emerged as an attempt to make the resources used in geoscience education more attractive to students, using digital technologies, and taking into account their presence in students' everyday lives [4]. Since nowadays society is increasingly digital, this study also aimed to contribute to the use of digital technologies to promote the development of literacies and skills related to digital technologies, since they can contribute to citizenship.

This study presents one of the first experiments carried out with transmedia in Geosciences education, if not the first. In the specific case of the Portuguese education system, there are few documented cases of the use of this type of narrative [5] and how its use can enhance teaching and learning, despite its potential for innovation in education. Up to the date of this study, no transmedia narratives were found for Geosciences education, which prevented the comparison of this study with previous ones.

In this context, this research aimed to contribute to the development of educational resources that are closer to the daily lives of students, with the help of digital technologies and transmedia storytelling, and that promote STS education, particularly in the Geosciences field. So, transmedia activities present a challenge and a tendency to connect school with everyday life.

### 1.1. Digital Technologies and Transmedia Storytelling

Traditionally, digital technologies have been used as tools to support teachers' practices and to prepare lessons (tests, Internet searches, presentations, spreadsheets and some educational software). Technologies have generally been used for knowledge transmission, and some authors claim that a real integration in pedagogical practices does not exist [6,7]. This situation is often related to the lack of skills and self-confidence of teachers for the use and integration of digital technologies in their educational practices [8–10], as they tend to use them mainly to research, organize and edit information. However, they apparently feel motivated to use it once they recognize that its use can bring several advantages to the teaching and learning process [9]. Among the advantages, teachers mention that classes can become more motivating to students and help them develop shared knowledge construction practices and collaborative work [8–10]. Digital technologies can also provide a wide range of tools that can pave the way for new approaches in the classroom and promote the development of digital and scientific skills and literacies [11]. As young people grow up surrounded by interactive media experiences, they seem to be open to innovative and modern practices, particularly in the educational system [12], such as transmedia storytelling.

Transmedia storytelling as a concept was first introduced by Henry Jenkins [13] and is broadly defined as a process where elements of a narrative are systematically dispersed across multiple media to create a unified and coordinated experience. According to this author, we are at a time where media convergence makes the flow of content through multiple channels almost inevitable, so that each part of the narrative exists in a given media and contributes to its development with the best that it has to offer. In this way, each new fragment makes a distinct and valid contribution to the whole. Ideally, each media plays a unique and specific role for the unfolding of the narrative and without experiencing each of those media, the subject is unable to fully understand the narrative. This makes it possible for the narrative, for example, to be introduced into a film and expanded to television, comics and games [13,14]. It is not a question of offering the same content through different media, but rather constructing an experience through which the narrative develops itself through different media, unveiling new and pertinent content and allowing the story to develop with that content [15]. Transmedia storytelling uses multiple platforms including digital technologies such as movies, games, simulations, videos, podcasts, television shows, web 2.0, e-mail, computers, tablets and mobile phones, but also uses more traditional media such as books, magazines, radio, comics, toys and newspapers [16,17]. However, all media should be related in a coherent and cohesive way and guide the overall user experience [17]. In this sense, it is critical to focus on the communicative aspect of the experience rather than the technology. Each user's experience is unique, unrepeatable and the route performed can be transformative. Thus, from a fruition standpoint, transmedia storytelling does not present a single predefined output since what is valued is the experience and this is not the same for all users.

Transmedia storytelling can also promote a high degree of interaction, participation and collaboration [14] and be reflexive, intertextual, social, user-generated, educational, informative and promotional [18], stimulating the development of multiple literacies and cultural and social skills [14]. Transmedia literacy, in this context, refers to a set of transmedia skills which includes skills related to the production, sharing and consumption of digital interactive media [19]. Scolari's team [19] has developed a taxonomy that is one of the most exhaustive skills maps that exists today, related to the production, consumption and post-production of media of young people's transmedia culture. According to this taxonomy, there are more than 200 general and specific transmedia skills, organized in nine dimensions (production, individual management, social management, performance, media and technology, narrative and aesthetics, ideology and ethics, risk prevention and content management).

The use of transmedia storytelling in education attempts to place the learning process closer to the social context of students, in which they socialize, have fun and learn in informal ways and with the mediation of technological artifacts [12]. This can be achieved because transmedia learning is flexible, can occur anytime, anywhere, and can be used across all age groups and in all learning environments [17]. Transmedia storytelling has the potential to engage students in immersive learning practices, according to their context and needs, since they already use media in an integrated way, although mainly for entertainment purposes [20].

Transmedia storytelling can also improve the development of critical thinking and problem-solving skills, engagement, integration, participation, collaboration, curiosity and knowledge building. The engagement in this type of experience can contribute to increasing the understanding of the subject under analysis, helping to make learning more effective [21]. Transmedia can also provide an opportunity to engage students in creative activities, leading to collaborative group work and collaborative intelligence [20]. Students are also invited to adapt the content and even to construct their own content, thereby encouraging creativity and innovation [22]. Transmedia storytelling implies consumption patterns based on participation [12] and the ability of users to decode, remix, create and circulate between various media types and across different contexts, including in-school and out-of-school environments [16]. Throughout this process, students can develop skills such as knowledge representation, imagination, multitasking, cognitive intelligence, transmedia navigation, networking, negotiation and the ability to create stories and participate in the community [14]. However, many young people do not have the ability to use digital technologies creatively and critically [18] as being born in a digital age is not a sufficient condition for being digitally competent [23].

Despite the developments that have been taking place in educational systems, transmedia has been used only occasionally [5], especially in science education.

### 1.2. Science-Technology-Society and Geosciences Education

According to some researchers [24–26], science education should include different purposes. Among these, those of a useful and predominantly practical nature stand out, including knowledge of science that is useful and usable in different contexts of daily life. Science education should also have democratic purposes, which encompass the knowledge and skills necessary for participation in society, specifically in decision-making on issues related to science and technology. Finally, it should include purposes that lead to the development of skills needed in the workplace, such as creativity, critical thinking and collaborative work. In addition, science education should promote the development of scientific ways of thinking and the construction of a realistic image of science as a socially and culturally contextualized human activity. Furthermore, it can foster the development of problem-solving skills and promote reflection on attitudes and values on issues concerning science and technology [26–28]. In this sense, science education can contribute to the development of all citizens in subjects comprising science, technology and its relations with society, becoming a science education with an STS (Science-Technology-Society) approach or orientation.

The STS orientation aims to promote, among other things, the construction of scientific knowledge, development of attitudes, capacities and values to address socially relevant issues concerning science and technology [29], and thus promote the development of scientific and technological literacy [29,30]. This orientation stresses the preparation of young people for the understanding of STS relations and the use of critical thinking to assess the advantages and disadvantages of scientific and technological innovations [31,32]. Hopefully, citizens will be able to participate in their analysis and resolution, in a conscious, responsible, democratic, informed, rational and evidence-based way [31,33,34]. STS education is also characterized by [29]: (i) the use of social themes that connect science and technology; (ii) the identification, exploration and resolution of issues with personal, local and global interest layers, which can arouse students' interest and, consequently, foster the development of knowledge, skills and attitudes about science, technology and their interactions with society; (iii) the active seeking of information in order to use it to solve the problem ahead; and (iv) approaching problems, issues or problem situations in interdisciplinary contexts.

Thus, the classroom, according to STS education, should be characterized by cooperation, interactivity, empathy and acceptance of all and should encourage questioning, argumentation and reflection. To teach with an STS orientation, educational resources should include socio-technological themes from which scientific knowledge can be exploited; focus on STS interactions, highlighting science and technology as human activities with social implications; and explore political, ethical, economic and social aspects associated with science and technology [29].

In this type of science education, teaching and learning strategies and activities should be incorporated in real contexts and include, for example, internships, field experiences and field trips and case studies or debates through the promotion of seminars by specialists [25]. The science education activities with an STS orientation can also include role playing, analysis of magazine articles, newspapers and television programs, solving open-ended problems that encourage decision making, writing argumentative essays, practical work and cooperation and collaboration between students [29,35].

According to these authors, group work on subjects related to everyday life is also one of the purposes of science education with an STS orientation. In activities like these, students' everyday situations should be used, which may contribute to bringing together their lives and school science. In this way, contextualization can promote more meaningful learning, since this type of approach can motivate young people to learn science, while simultaneously promoting the development of crucial skills for citizenship [35]. In this context, the topic addressed in this research, related to the use that human beings make of rocks in everyday life, can promote the connection of transmedia activities to the context of the students, as well as allow them to realize the importance of Geosciences.

Geosciences education is increasingly necessary, as it contributes to the development of important skills to deal with relevant issues in everyday life [36]. Although materials from Earth are vital to the economy of any country and natural disasters are spread across the world, education in geosciences is often seen as a low priority area and there is a lack of awareness of the importance of geosciences [37,38]. Thus, it is crucial to have a population that is literate in geosciences, who knows natural hazards, who knows how to act on them and who values the importance of developing policies that consider scientific knowledge in this area [36–38].

In Portugal, there is a relationship between the buildings and the regional geology of an area, which demonstrates the importance of certain geological resources, such as rocks, for the social, cultural, technical and economic development of populations [39]. The applications of geological resources in everyday life, in sophisticated technological equipment or the recognition of rocks in buildings that defy centuries of history support the importance of the existence of basic scientific knowledge in this area [36,39]. On the other hand, the vast majority of materials used in urban construction, from the rock used in the pavement to the tiles, including ornamental stones, have geological origins and the fact that the majority of the population lives in urban areas constitutes an opportunity to use elements of urban geology, such as rocks, in outdoor educational activities [39]. In addition, the use of common buildings, like monuments, can provide active and integrated learning [40] and a reflection on the importance of geosciences in urban areas [39]. The development of geological culture allows the real world to be treated in the classroom and taken outside the school, into the daily lives of students, contributing to the respect and appreciation for the natural environment and buildings such as some important national monuments [36,37]. According to these researchers, geosciences, through contact with nature, is a privileged course insofar as it takes the classroom out to the world, potentially increasing the sense of belonging to a given place and the identification between the individuals and the geological history of the place where they live.

In this regard, Pedrinaci [38] defined a set of goals for geoscience literacy: (i) having a global view of how the Earth works and knowing how to use these competencies to explain, for example, the distribution of earthquakes and volcanic activity, or to understand the causes of changes taking place on the planet; (ii) establishing a temporal perspective for the changes that took place on Earth and the organisms that populated it, in order to provide a better interpretation of the present-day; (iii) understanding the main interactions between humanity and the Earth, geological risks, dependence on geological resources and the need for their sustainable use; (iv) being able to search for and select information about terrestrial processes, asking questions and assessing whether the evidence supports the conclusions; and (v) knowing how to use basic geological principles and procedures and value their importance for the construction of scientific knowledge about the Earth.

## 2. Methods and Materials

This study is predominantly qualitative in nature [41–43] and is based on an educational design research (EDR) methodology. EDR is developed in a real context and comprises a cyclical and reflexive process of design, development and evaluation of educational interventions. These interventions aim at contributing to the resolution of complex and significant problems or to develop theories about teaching and learning processes or learning environments, such as the introduction of transmedia activities in the teaching of geosciences [44–46].

According to several researchers [44–46], EDR is: pragmatic, because it aims at generating new knowledge and useful solutions to problems in educational practice; interventionist, as it aims to develop an intervention in a real context and change a given educational context; iterative, as it evolves through multiple cycles of design, development and evaluation; utility-oriented, as it assesses practicality for the user; process-oriented, as it implies understanding and improving the interventions produced; adaptive, since the intervention is continually modified according to new findings; and oriented by and for theory, because it is based on theoretical assumptions, but can also contribute to its development. The characteristics of EDR that were followed during this research include: (i) a real educational context, in this case, in the study of a subject of the Natural Sciences course, which gives validity to the research and ensures that data can be used in an effective way to improve practices; (ii) a variety of research techniques and instruments, such as surveys (by questionnaire) and observation; and (iii) multiple iterations, involving cycles of conception, production, evaluation and review of the intervention, in this case, the transmedia activities developed. It should be noted, in this regard, that the present research was implemented in two academic years, 2017/2018 and 2018/2019, which constituted two research cycles, with the second research cycle resulting from the analysis and revision of the first. The first research cycle, in 2017/2018, was developed with 7th graders, and the second research cycle, in 2018/2019, involved 5th graders.

The research question in this study was: "What are the contributions of transmedia activities for the development of thinking skills and the mobilization of students' scientific knowledge?".

To answer this question, it was decided to use transmedia storytelling due to its potential, demonstrated in some international projects [15,22,47], to promote the development of digital skills, media literacy, engagement and teamwork. In addition, the need to introduce educational resources that consider digital technologies that students use on a daily basis and that are not always used in the classroom was also considered. The characteristics of science education with an STS orientation that served as the basis for the elaboration of these transmedia activities resulted from the literature review previously presented and synthesized. In this context, the activities had the following characteristics: use of themes that involve science and technology and that are included in the curricular guidelines; exploration of issues with personal, local and global interest that can arouse students' interest and that enhance the development of attitudes, values and scientific knowledge; and student engagement in searching for relevant information concerning the Geosciences.

### 2.1. Transmedia Activities

For the development of the transmedia activities, a subject of the Natural Sciences course that had the potential for the integration of transmedia from an STS perspective was first selected. After a careful analysis of the official documents [1,2], it was decided to select the theme related to the use that human beings make of rocks in everyday life.

The reason that two different grades were selected, 5th and 7th, was related to the teachers' willingness to include this type of activity in their teaching practices. Furthermore, despite the fact that rocks are treated with different degrees of depth at these levels of education, rock identification in hand samples is a common topic. In this way, rocks common to the two grades and which had been previously studied by students in the classroom were selected for the transmedia activities. On the other hand, the definition of the activities took into account the type of scientific detail needed to identify these rocks.

Since the intention was to use transmedia, a narrative was also created about the history of a girl named Lara, who recently moved to the city of Aveiro (a coastal city at the center region of Portugal). To get to know the city, the girl's mother bought an online puzzle about human beings' use of rocks in everyday life. The construction of this puzzle implies visiting pre-defined places in the city, which allows the girl to get to know it better. Moreover, in each of those places the girl had to carry out specific activities, such as identifying the type of rock in previously selected monuments. This narrative served as a framework for the set of activities that the students would also carry out. Therefore, like the girl, the students had to visit defined places and, in each of them, carry out a set of tasks framed in a field trip.

At a later stage, the information gathered would be shared in an online group of the Campus digital platform. This resulted from an adaptation of the activities to the school reality since the field trip had to be carried out during a 90-min class.

The ultimate goal of each student was to complete an online puzzle. During the implementation of the activities, it was intended that the main character of the narrative, through a set of clues, would lead the students from one station to the next, and the clues left by her could suggest the use of different media. In addition, at each of the stations of the field trip, the character herself left aids to the students, since, according to the narrative, she was also participating in the field trip. Thus, the character gave indications of the particularities of the rocks that she had also found along the places she would have visited. Each field trip station worked as a part of the narrative and, consequently, of the story of the girl.

In addition, we tried to include activities that could contribute to the development of skills in specific areas, such as Interpersonal Relationship, Information and Communication and Critical Thinking and Creative Thinking. For example, regarding the information and communication area, the activities that were designed sought to develop skills through the use of the Campus platform where students could interact online with colleagues and/or the researcher. The development of competencies in the critical thinking and creative thinking area could take place through, for example, the creation of a creative photograph and/or video at station 3 of the field trip. The competencies related to the interpersonal relationship area could be developed during the field trip, through interaction with others and during teamwork. Finally, in relation to the scientific, technical and technological knowledge area, skills development could occur through the application of scientific knowledge to new situations, specifically the identification of rocks, during the field trip, which had previously been addressed in the classroom.

For the implementation of the activities, these were divided into three moments [48]: before the field trip, field trip and after the field trip. Each of these phases was an independent learning unit and, at the same time, served as a bridge to the next learning unit [48,49].

#### 2.1.1. Before the Field Trip

In this phase, students usually deal with basic concepts that are necessary for that particular field trip and therefore it includes only those that will be observed in that field trip, as well as the processes and rocks that will be observed [49]. During this stage, students should familiarize themselves with the scientific knowledge and the activities they will participate in (cognitive preparation), the area of the field trip (geographical preparation) and the type of tasks involved (psychological preparation). However, as the field trip took place close to the school, it was considered that geographical preparation would be unnecessary.

On the other hand, this phase took place as part of a formal teaching class, where each student was provided with a student guide and the teacher's guide was previously provided to the teacher. The student guide included the narrative, the rules and recommendations for the operation of the activities, the indications for the geographical location of the first station of the field trip (the remaining information being provided to the students during the field trip through the narrative character), the total number of stations and indications on the operationalization of activities in each of its phases. In this regard, it should be noted that the field trip of this research took place after students' study of rocks in the classroom.

#### 2.1.2. Field Trip

The field trip is considered, by Orion [48,49], an integral and indispensable event in the learning process. Usually, the field is a natural laboratory where students can touch rocks, observe and investigate geological phenomena and discover geological concepts and principles [49,50]. The field trip area must be in the school's proximity and be formed by 6 to 8 stations, the observations at each station must be clear, the stations must be easily accessible and safe, there must be enough space at each station for all students, the distance between stations must not exceed 15 min on foot and all stations must be related to a certain theme [48].

In this research, the field trip was formed by a set of six stations situated near the participants' school and was integrated into the Natural Sciences curriculum. On this field trip, each station corresponded to a different rock, with the exception of limestone, which is repeated in two stations due to its importance in Portuguese pavement, in Aveiro's region and in the city itself. To carry out this phase, a student guide was prepared, which was formed by the clues and information to be made available to the students at each station. At each station, students had to carry out a set of similar activities (Table 1): macroscopically identify the rock (limestone, shale, marble, basalt and granite) at that location, or follow directions to identify a particular rock according to the received clue; write down their observations and record the observed rock with a photograph and/or a video; write down the information collected on the respective field guide; mark the geographic location on the map previously created in Google Maps or write down this information on the field guide; and decipher the clue leading to the next station. Students saved all this information, completing a paper field guide previously distributed to all students and taking pictures, since this information would be needed it in the final phase of the activities. The areas of competence of these activities are part of an official document of the Ministry of Education of Portugal, the *Perfil dos Alunos à Saída da Escolaridade Obrigatória* (Profile of Students at the End of Compulsory Education) [51].

**Table 1.** Activities to be carried out by students on the field trip and areas of competence [51] that can be developed.

| Station(s) | Activities | Areas of Competence [51] |
|---|---|---|
| 1 and 5 | Macroscopically identify a limestone sample | Scientific, technical and technological knowledge |
| 2 | Macroscopically identify a schist sample | Scientific, technical and technological knowledge |
| 3 | Macroscopically identify a marble sample | Scientific, technical and technological knowledge |
| 4 | Macroscopically identify a basalt sample | Scientific, technical and technological knowledge |
| 6 | Macroscopically identify a granite sample | Scientific, technical and technological knowledge |
| 1, 2, 3, 4, 5 and 6 | Record observations in photo and/or video, for example, on students' mobile phone | Information and communication |
| 1, 2, 3, 4, 5 and 6 | Record observations on the field guide | Scientific, technical and technological knowledge |
| 1, 2, 3, 4, 5 and 6 | Mark the geographic location on Google Maps or the field guide | Information and communication |
| 1, 2, 3, 4 and 5 | Decipher the clue to the geographic location of the next station | Scientific, technical and technological knowledge |
| 1, 2, 3, 4, 5 and 6 | Group work with, for example, collaboration between group members to carry out the tasks of each station | Interpersonal relationship |

### 2.1.3. After the Field Trip

The phase after the field trip was intended to include more complex concepts that require greater capacity for abstract thinking and a greater level of concentration on the part of students. During this phase, the experiences and knowledge resulting from the field trip can help to overcome the difficulties associated with scientific knowledge in the area of geosciences [48,49].

After the field trip, students shared in the Campus digital platform all the information gathered in order to build the puzzle. The choice of this platform was made taking into account the privacy of students, who were minors; the potential of the platform for the development of this type of activity, since it allows sharing and exploring Internet resources related to the activities' theme; and the possible constitution of a learning community. In this phase of the activities, the researcher assumed a central role in stimulating the platform group, launching activities and discussions. Thus, a support guide was prepared to promote the activities in the Campus platform. In order to prevent the digital community from functioning only as a repository of content, some activities related to the subject and the presence of science and technology in daily life were included. For example, the assignment of pieces of the puzzle was interspersed with activities on: identification of an application of the rocks at the student's home, identification of a mineral used at school, the importance of maps to portray the earth's surface, the consequences of human life beyond the possibilities of planet Earth, the situation regarding plastics in the oceans, the consequences of pollution associated with the exploitation of geological resources and the geodiversity in Portugal. In addition, the group itself allowed communication between students, and the researcher encouraged the students to carry out the activities and to encourage their colleagues to participate. Students could also visualize the work done by others and the status of the collection of puzzle pieces in each group of students. However, in situations where students were unable to collect one of the pieces of the puzzle, for example, due to the incorrect identification of the rock sample from a given location, they would be given a second opportunity. This consisted of obtaining a new clue that would take them to a new location, where they would have to follow the directions left by the character in the narrative.

The puzzle was made of six pieces and represented a free admission to a Science Center. This moment also included activities in which students could collect digital badges. Badges corresponded to digital images that were intended to recognize the performance of certain tasks or the certification of learning [52]. Thus, the complete puzzle corresponded to a badge, "Conquest," and the tasks associated with station 3 corresponded to a badge, "Recognition".

### 2.2. Data Collection Instruments and Treatment

The data collection instruments used in this research were the following: questionnaire on the use of digital technologies by students, researcher's diary, learning checklists, field guide filled in by students during the field trip and questionnaire to students at the end of the activities. In this work, we tried to use a set of instruments that would allow us to obtain information that would enable the triangulation of data in order to enhance the fidelity of the information collected [53]. Thus, in this research, data collection instruments were selected in order to allow us to obtain quantitative and qualitative data in a complementary way, although qualitative data predominated.

Data processing techniques included descriptive statistics and content analysis (Table 2).

**Table 2.** Instruments and techniques for collecting and analyzing data.

| Instrument | Technique |
|---|---|
| Questionnaire on digital technologies | Descriptive statistical analysis |
| Researcher's diary | Content analysis |
| Learning checklists | Descriptive statistical analysis<br>Content analysis |
| Field guide (Student records on field trip guides) | Descriptive statistical analysis<br>Content analysis |
| Final questionnaire | Descriptive statistical analysis<br>Content analysis |

Descriptive statistics was used to process data from questionnaires applied to students, learning checklists and the field guides. Within the scope of the present research, content analysis was used to process the data collected through the student guide, the researcher's diary, the learning checklists and answers given on open questions of the final questionnaire given to students.

Content analysis involved a set of five steps [43,53,54]: constitution of the data corpus, definition of analysis categories, data coding, data categorization and inferential and interpretative treatment of the data. In the first stage, constitution of the data corpus, the students' responses to the questionnaires and the field guides were collected, an exhaustive reading, called floating reading, of the collected documents was carried out and the checklists and field guides were verified and the researcher's diary was analyzed.

In the next phase, the categories of analysis were defined, considering students' scientific knowledge about the scientific theme, the attitudes and values studied in this research and students' digital competencies. Thus, three categories of analysis were defined: mastery of digital technologies, thinking skills and mobilization of scientific knowledge and attitudes related to group work. During the next phase, data coding, the relevant records and/or episodes were coded into pre-defined categories according to the research phase in which they took place, for example, field trip. Also, at this stage, the answers to the questionnaires were coded according to the numbering of the questions in that instrument. For example, questionnaire 1 (concerning digital technologies used by students), answer to question 1 of part II, coded with Q1-II.1. A similar situation occurred with the coding associated with the learning checklists, with the results being coded according to their indicators. Regarding the field guide filled in by the students during the field trip and the researcher's diary, an analytical reading was carried out to encode the recording units related to the students' written productions and the relevant situations that occurred during the field trip. In the case of the researcher's diary, the recording units were coded, for example, with Session1, class I, RD records. Finally, during the inferential and interpretative treatment of the data, a descriptive synthesis of the relevant records from the researcher's diary was carried out, as well as an interpretative relationship between the coded recording units and the previously elaborated categorization.

The first instrument implemented aimed to better understand the target audience of this research. This instrument was prepared to characterize the use of digital technologies by the participating students in order to use, in the course of transmedia activities, devices and applications familiar to the students. This questionnaire was prepared based on other existing and validated instruments [55,56] on the same topic, having been adapted to the objectives of this research. The instrument was validated by the supervisors of this research and also by the coordinating teacher of the Natural Sciences discipline from the school. The instrument used was elaborated and validated during two prior PhD studies, by Alves [55] and Lopes [56], and was intended to characterize their participants' digital practices, namely the possession of digital technologies, the frequency of its use, including web 2.0 tools, and the level of knowledge concerning those technologies. Although originally elaborated for adults, changes were made in order to adequate the questions for young people. This final version was validated as mentioned earlier.

The questionnaire consisted mostly of closed-ended questions, including single closed-answer questions (example: yes/no), multiple (example: Mark your answer with an "X". You can select more than one option) and Likert scale (example: Every day or almost every day), the latter being the ones that existed in greater number. The scale adopted coincided with that of the questionnaire that served as the basis for the construction of this instrument. This data collection instrument was applied by the Natural Science teachers in a classroom context. The data obtained from these questionnaires were processed, using Microsoft Excel, and organized into frequency tables, presented in absolute values, from which graphs were constructed to carry out their descriptive analysis.

Another data collection instrument used in this study was the researcher's diary. This diary presents descriptions of the phases before the field trip and field trip and other meetings with the students. That document was organized by days and describes how each activity took place with the students, how they reacted to the activities, their difficulties and the observed behaviors, as well as reflections on positive and negative aspects about the development of the activities, aspects that could have been different and some situations considered relevant to the research. The researcher's diary is therefore based on descriptive and/or reflective records, in detail, of the researcher's experience, of dialogues between the participants, notes on behavior and decision-making notes [41,43]. In this context, observation was one of the techniques used during the implementation of activities. The data collection instrument that accompanied the observation was the learning checklist built for this purpose and validated by the supervisors of this research. The learning checklists were elaborated considering the curriculum documents [1,2,51]. Thus, this instrument includes indicators that make it possible to verify the presence of scientific concepts related to the theme of rocks and certain skills. It was also after the sessions with the students that the researcher filled in the learning checklists. The data collected with this instrument were subjected to a comparative content analysis regarding the indicators that constitute it and the areas of competence in which they can be included.

The field guide that was filled in by the students during the field trip was prepared based on the research recommendations [50]. As with the other data collection instruments, the validation of this instrument was also carried out by the supervisors of this work. The main objective associated with this data collection instrument is to verify if the students mobilized scientific knowledge during the field trip. The field guide was collected at the end of the field trip, in order to verify which notes the students had made and if they had correctly identified the rocks and the geographical location of each station. The processing of data collected through the field guides included its quantitative analysis, in order to determine what percentage of students had correctly carried out the activities at each station of the field trip, namely the identification of the rock and the geographical location of each station. For this instrument, content analysis was also performed, as described above.

At the end of the implementation of the activities, the students' opinions were collected through a questionnaire. This instrument was prepared based on a previously existing and validated instrument [57]. In this study, a Master's thesis, Moreira [57] intended to evaluate the impact of his didactic resources, built according to an STS approach and concerning continental drift and plate tectonics, with students from the 7th grade. The version used in the present study was slightly changed, namely in the formulation of questions, in order to answer the objectives of this research. Regarding its structure, this instrument comprised two sections. The first part, made up of closed questions with Likert scale, referred to the general appreciation of the activities, and the second, made up of only three open questions, was intended to collect a free opinion from the students about the activities and their participation in the Campus platform. This questionnaire was prepared in electronic format and its treatment involved content analysis as mentioned above.

## 3. Results

A total of 102 students participated in this study, 21 attending the 7th grade and 81 the 5th grade. In this section, the results obtained will be presented considering the three categories of analysis mentioned above, namely: mastery of digital technologies, thinking skills and mobilization of scientific knowledge and attitudes related to group work. Additionally, the results will be presented according to the phase of implementation: before the field trip, field trip and after the field trip.

### *3.1. Before the Field Trip*

The first phase of this research was before the field trip. This phase was essentially introductory and consisted of introducing students to the activities they were going to carry out. Therefore, the results presented in this section, for this phase, are mainly based on the information contained in the researcher's diary.

Regarding the mastery of digital technologies category, in the first contact with the students, the researcher found that most students in the 7th grade knew what online means and what digital badges are, unlike the younger participants, which indicates some differences between the students.

The results of the initial questionnaire showed that the majority of the students use technological devices, especially mobile phones and tablets. In the 7th grade, 18 students owned a mobile phone and/or a tablet (Figure 1), mainly with Internet connection.

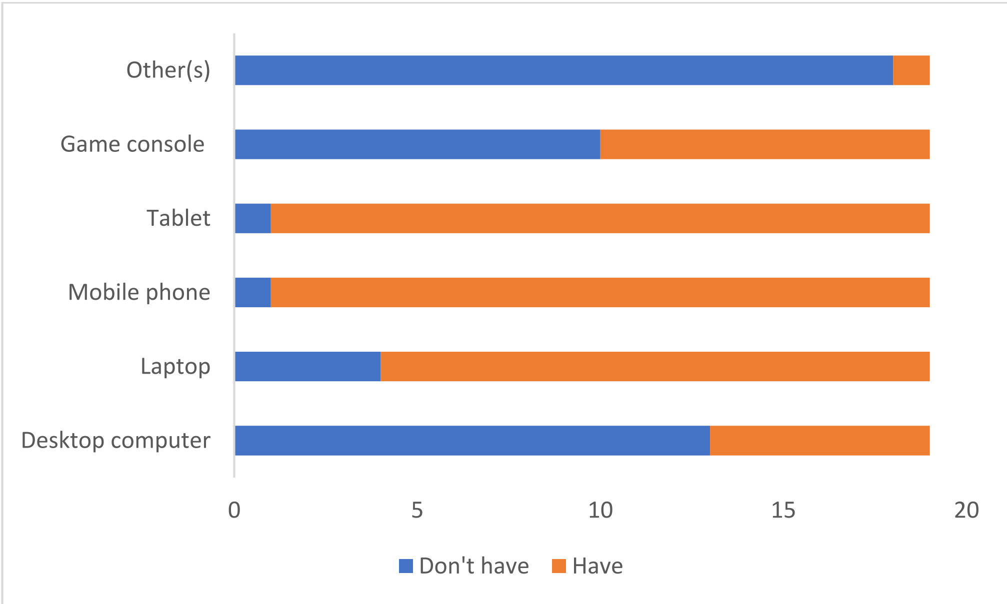


**Figure 1.** 7th grade student's ownership of digital devices.

On the other hand, 5th grade students (Figure 2) reported owning a mobile phone (70 students), tablet (61) and/or laptop (54). Most of these devices do not have an Internet connection.

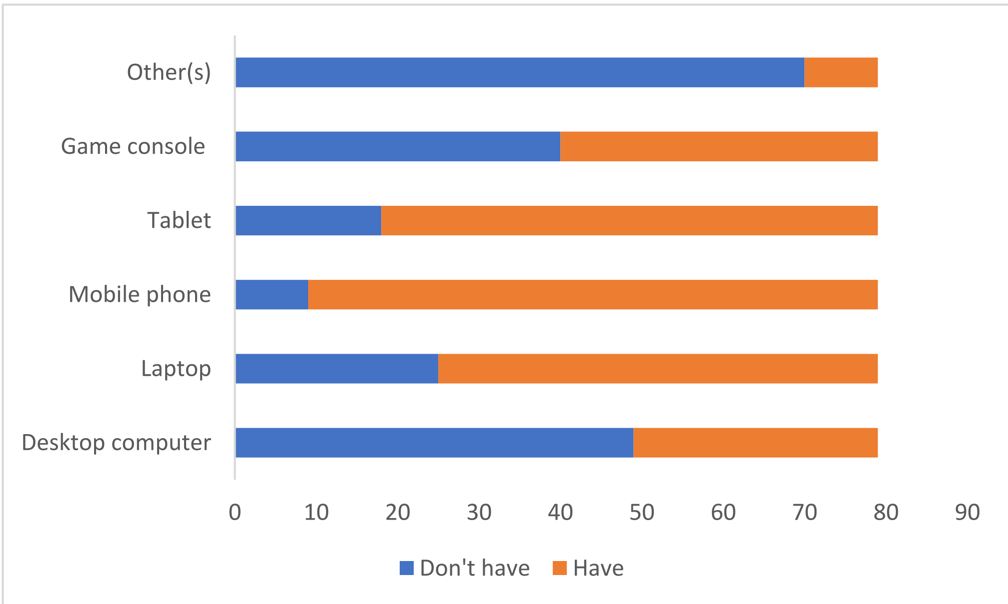


**Figure 2.** 5th grade student's ownership of digital devices.

When asked about the level of knowledge they had about web applications or services, students in both grades reported having good knowledge about video sharing tools, chat or videoconferencing communication and participation in communities or social networks.

In the case of the 7th grade (Figure 3), half of the students (9) reported excellent knowledge of video sharing tools, chat or videoconferencing and participation in communities or social networks. In this question, it is worth noting that a considerable number of students reported not knowing collaborative work tools (12 students), blogs (12) and Campus platform (18). Most of these students have an Instagram account (14 students).

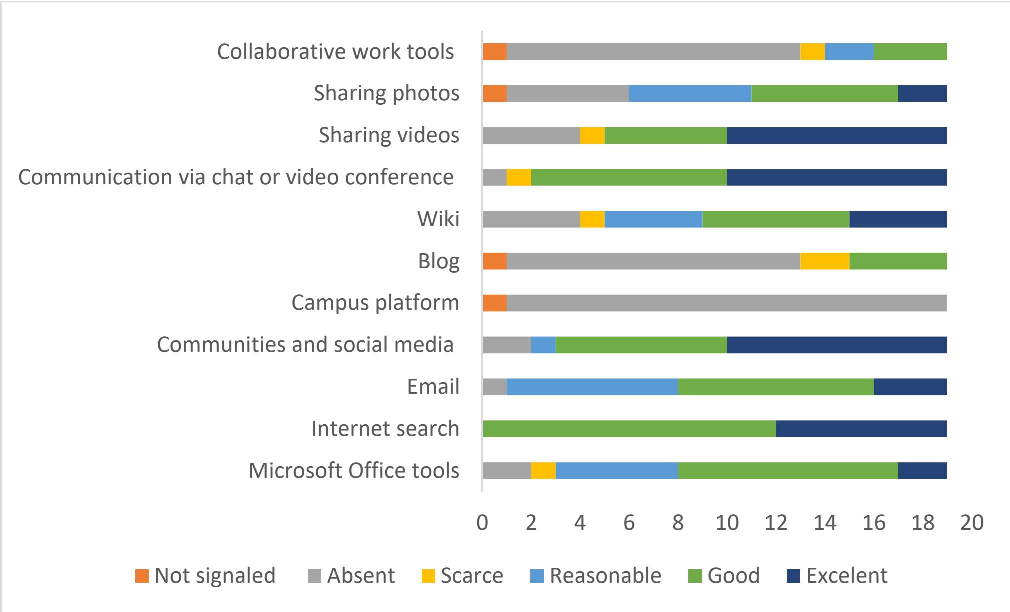


**Figure 3.** 7th grade student's level of knowledge about web applications or services.

5th grade students (Figure 4) reported excellent or good knowledge of video sharing tools (56 students), Internet search (58), chat or videoconferencing tools (57) and participation in communities or social networks (48). However, many students reported not knowing collaborative work tools (46 students), photo sharing (42), blogs (37) and Campus platform (59). The majority of these students do not have an account on social media. For instance, only 20 of them have an Instagram account.

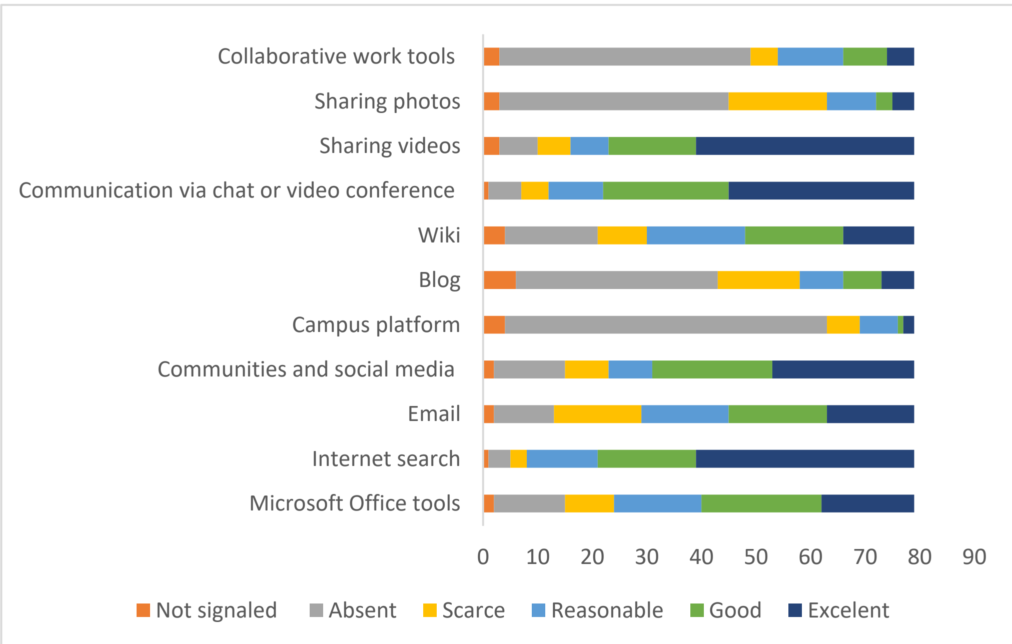


**Figure 4.** 5th grade student's level of knowledge about web applications or services.

When asked about activities performed on devices connected to the Internet, students prefer watching videos, listening to music and using instant messaging applications.

7th grade students (Figure 5) reported a preference for watching videos (15 students), listening to music (14), using instant messaging (13) and participating in social networks (9).

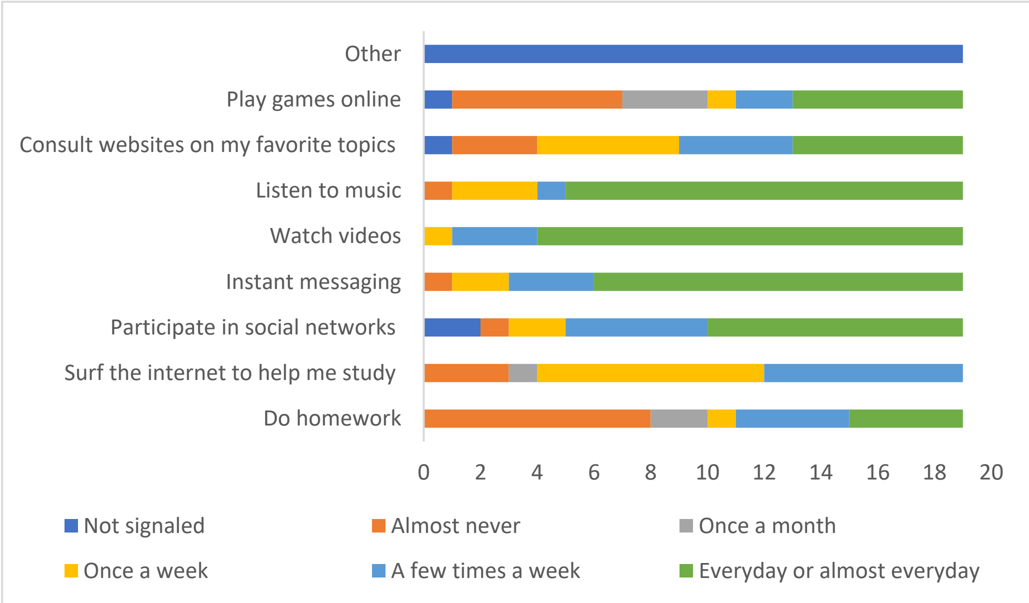


**Figure 5.** 7th grade student's activities online.

Finally, 5th grade students (Figure 6) prefer watching videos (42 students), listening to music (32, doing homework (30) and using instant messaging (26). However, these students use digital devices less frequently than the older ones.

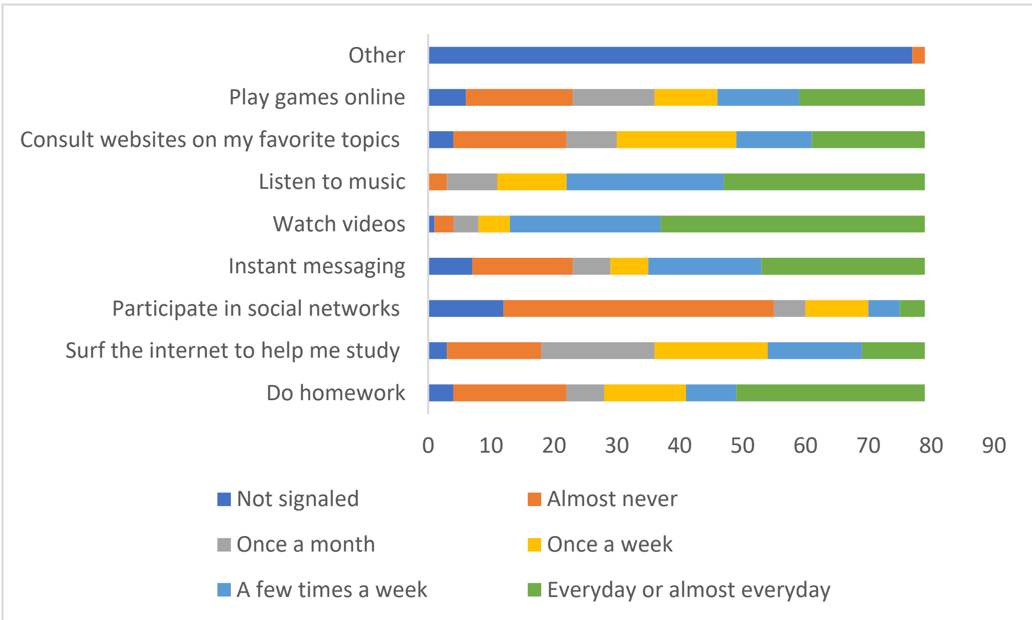


**Figure 6.** 5th grade student's activities online.

Students' main concerns in this phase were related to how they would be able to take photos during the field trip, that is, if they could use their own mobile phone, how they would be able to take notes of the observed aspects, if they had to discover the geographic location of the first station on the same day they received the GPS coordinate for the geographic location of station 1 of the fieldtrip and if it was possible to use the Campus platform on a mobile phone. Finally, and as it was observed on the day of the field trip, the students showed some ability to search on the Internet, since at the time of the field trip all students knew the geographical location of the first station.

With regard to the categories related to thinking skills and mobilization of scientific knowledge and attitudes related to group work, no results were collected at this stage that fit into them. This was due to the essentially introductory character of this phase of the activities.

*3.2. Field Trip*

The results relating to the field trip were based on the information obtained from the learning checklists and the students' field guides and, whenever justified, the information was supplemented with the data contained in the researcher's diary.

Regarding the mastery of digital technologies category, the results show some concerning aspects. The indicator "Choose the most appropriate digital technologies for the creation of digital content (photo and/or video)" was not observed in either the 5th or the 7th grade. These students limited themselves to using their mobile phone camera to take pictures and videos without any kind of improvements.

The indicator "Search for information in a digital environment" was found in students in the 7th grade, but not in the 5th grade students. For example, to find the geographical location of station 5, students had to associate it to the location of the monument in honor of Zeca Afonso (a Portuguese singer and songwriter) from one of his songs, a task that was not achieved by any student. In the case of 7th grade students, the research they carried out did not lead them to the desired information. These students, from the clue to station 5, a link to a song, identified its composer, Zeca Afonso, but many of them just put that name in the search field and, as they started out with only the results of the songs, they could not, from there, find the desired information. One of the groups found a photo of the monument from that station and still could not continue the search and find its geographical location. However, at the beginning of the field trip, all students knew the geographical location of station 1, including the 5th graders. It should be noted that the clue to station 1 was a GPS coordinate that was given to students one week before the field trip.

Next, the results obtained for the category thinking skills and mobilization of scientific knowledge are presented. The field guides that students filled in during the field trip were the main source of data and the results were similar for the students from both grades. In this case, it was found that the records made by students were, in general, of low quality, since they limited themselves to writing down the name of the rock (for instance, for station 1, limestone) and the name of the street where the station was located (for example, for station 1, Rua do Sport Club Beira-Mar), despite its having been mentioned by the researcher, at the beginning of the field trip, that the document could be used, for example, to make drawings and write down everything that could be relevant, including for the next phase of the activities. However, it should be noted that, in all stations, the correct identification of the rock and of the geographical location prevailed.

It was also found that the indicator "Builds arguments to take a reasoned position" was not detected in students from both grades. The indicator "Can disentangle the information constituting the clues" was also not verified in any group of students. Regarding the indicator "Correctly identifies different groups of rocks", this was verified in the 7th grade and only in a few students of the 5th grade. However, in this case, the clues were different and adapted to the different scientific knowledge of the students from 5th and 7th grades. Students showed difficulties in interpreting the clues distributed in each station and the clues that directed them to the next station. Students read the clues without attention, could not independently search the Internet and asked the teacher and the researcher for help whenever they were unable to carry out an activity. When identifying the rock, they did so through the visual aspect and not considering the details of the clue received and the mineralogical composition observed in some rock samples. For example, in the identification of the granite of station 6, the students identified the rock considering the information present in the clue they received, although the rock presented an aspect in which the basic mineralogical composition of this type of rock was visible (quartz, feldspar and mica). This mineralogical composition was previously studied by students of both the 5th and 7th grades. On the other hand, it seems that the students did not read the clues left by Lara and, perhaps because of this, they may also have had difficulty in knowing which rock they had to identify.

Regarding the category attitudes related to group work, the results are as follows. The indicator "The group was able to resolve conflicts and reach consensus" was found only in students from the 7th grade. On the other hand, the indicators "Orally share their ideas with colleagues" and "Actively participate in tasks" were found in all groups of students from both grades. At the opposite extreme is the indicator "Reveals autonomy", since it was not observed in any group of students. Regarding the indicator "Listen carefully and respect the ideas of others", this was not verified in some 5th graders. The indicator "Mutual help" was found in the 7th grade, but only in some of the 5th graders.

### *3.3. After the Field Trip*

The phase after the field trip was intended for students to use a closed group on the Campus platform to share the information collected in the previous phase and, from there, to be able to collect the pieces of the puzzle and, in some cases, digital badges. However, students did not participate in this phase, which can be attributed to several factors, as discussed in the next section.

At the end of this research, a questionnaire was given to the students. In this case, we only received responses from 8 students, despite our best efforts. These students considered the time they had available to carry out the activities and the physical space where the field trip took place to be adequate, and they considered themselves to have respected the rules, committed themselves and managed to solve the activities and they considered the group work to have been an asset. Students also considered the clues to be easily interpreted. Regarding the ability to argue, the students considered themselves to have this ability, and only two of them recognized that it is poorly developed. In sharing ideas with their peers, most students responded that this sharing occurred. The students recognized that the activities carried out aroused their interest and that the acquired scientific knowledge can be useful for everyday life. When asked if they participated in the phase after the field trip, seven students replied that they did not. Reasons for this included lack of interest, time and knowledge about which platform to use. The student who participated mentioned that he did so only occasionally, "because I liked the experiences we had". The difficulties felt by the students while carrying out the activities included difficulties in interpretation ("Perceiving the meaning of the questions"). Two students reported that they had no difficulties and two indicated that they do not remember. Finally, regarding comments and suggestions that young people considered important, six students did not present any type of comment, one student mentioned that another platform should be used, because the Campus "was not practical and easy", and yet another student said that activities should include more clues, questions and quizzes.

## 4. Discussion

The discussion of the results obtained in this research was based on the data obtained with the different data collection instruments implemented. The following results are discussed for each of the implementation phases of the activities: before the field trip, field trip and after the field trip.

### 4.1. Before the Field Trip

Concerning the phase before the field trip, the results belonging to the mastery of digital technologies category are analyzed first. According to the initial questionnaire, the main digital device students use is the mobile phone, which is reported to be used every day or almost every day. This fact is validated by other studies carried out with Portuguese students [58,59]. Regarding the frequency of use of services and web applications, there are considerable differences between the students of the two grades analyzed, which can be explained by the fact that students of the 5th grade use the Internet less frequently. On the other hand, skills related to navigation are among the ones that students perform the most, which is in line with the results of other studies [59]. These results are also in agreement with other studies [7,60] that concluded that digital practices related to entertainment (listening to music online, playing online games, participating in social networks) are predominant. In this sense, these students are essentially consumers, instead of content producers.

In addition, the students surveyed considered themselves to have good knowledge about web applications and services, which was also verified in other studies [61]. These students have accounts on social networks, specifically Instagram and Facebook, which is also in line with other studies [59] that mention that the social network preferred by young people is Instagram. Similar results have also been obtained internationally [62,63]. According to these researchers, students tend to use Facebook and Instagram, since these social networks are easy to use and they can find and follow their friends there. Most participants in this research revealed that they were not familiar with the Campus platform, which may have influenced their participation in the phase after the field trip. According to several studies [62,63], platforms unknown to students, and which they find difficult to use, are not generally adopted by them.

The most striking aspect of this phase was the observation that students had difficulties assimilating all the information in the time available for this purpose. Thus, it became difficult for students to know in detail the characteristics of all phases, since it was a lot of information for them to process. Thus, the information should be given to students throughout the development of the activities instead of providing all the information in the initial phase. In addition, from the above, it was found at this stage that most students demonstrated some gaps in the area related to information and communication skills.

### 4.2. Field Trip

In the field trip phase, it was found that there is no agreement between the results evidenced by the students in the answers to the questionnaire on the use of digital technologies and the observations made by the researcher during the field trip.

During this phase, students revealed a level of digital skills below those that emerged from the characterization of the initial questionnaire. Despite this, at the beginning of the field trip, all students knew the geographical location of station 1, but they may have had help in finding it. Students may have asked other classmates or their parents to help them decipher the GPS coordinate. It should also be remembered that during the field trip, discovering the geographical location of station 5 required deciphering the location of the monument in honor of Zeca Afonso from one of his songs, which was not achieved by any of the students. The 7th grade students showed that they know the search engine to use, but they were not able to use a keyword that would lead them to the desired information. On the other hand, this fact may indicate that the clue for station 5 has a high degree of difficulty. In order to determine the location of this station, it was first necessary to discover that the music available was by Zeca Afonso and, from that information, to verify that there is a monument to this musician in the city of Aveiro and to discover its respective geographical location. With regard to the Internet search, students who answered the questionnaire at the end of the activities reported some difficulty in carrying out this type of task, which was clearly observed during the field trip. However, since on the field trip, all students had managed to decipher the geographical location of station 1, which was a GPS coordinate, it can be said that they had some skills in the area of information and communication, despite the difficulties manifested in carrying out certain tasks involving digital technologies.

In this sense, it may be considered that students can be assigned tasks to find places related to GPS coordinates, with some time to be dedicated to this task.

Regarding the category of thinking skills and mobilization of scientific knowledge, there was a (re)construction of scientific knowledge related to the macroscopic identification of rocks, at least in some students. Despite rocks being a subject previously addressed in classes, most students could not identify the rocks with the help of Lara's clues or through their visual aspect. This situation occurred because, as it was seen in the field trip, the students did not read carefully the clues left by Lara and, therefore, they may have had difficulty in knowing which rock they had to identify. Furthermore, even when the clue led to the identification of a particular rock, for example, to identify a magmatic rock predominant in the Azores and Madeira archipelagos which, for 5th grade students, could only be basalt, the students showed some difficulties. On the other hand, even after knowing that the rock to be identified was basalt, the students could not identify it macroscopically. However, the field trip station where this occurred (station 4) presents a high degree of difficulty (Figure 7), since it is a wall formed by a wide variety of rocks, some of them similar to each other. Thus, the failure to identify this rock may be related to the difficulty of finding basalt in the wall, since it is not very abundant and, therefore, is difficult to find.

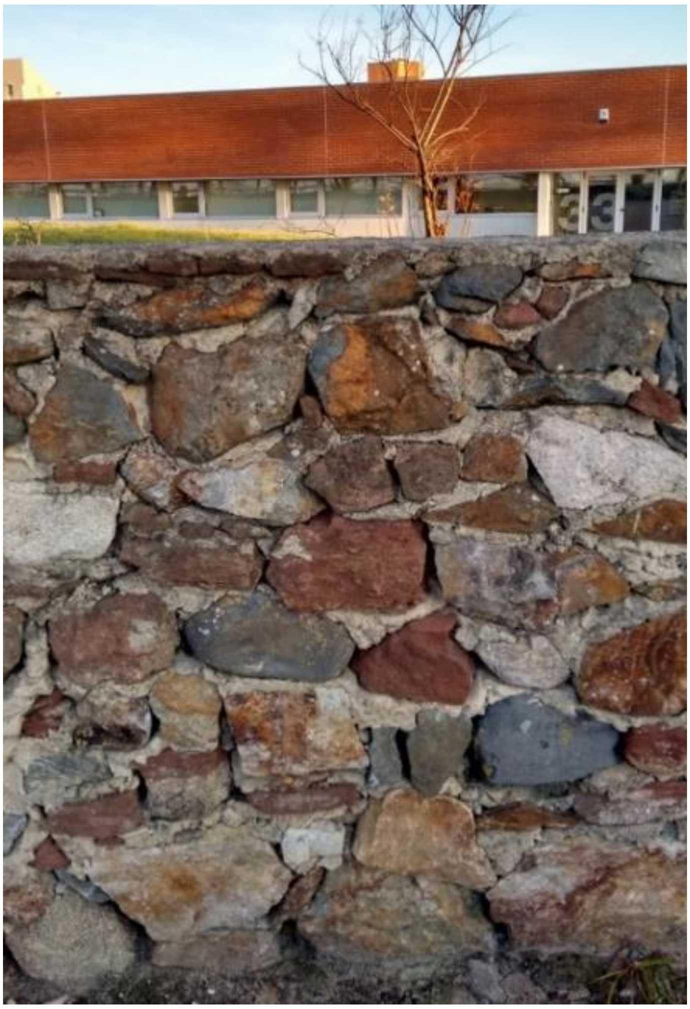

**Figure 7.** Station 4 overview, where it is possible to observe various types of rocks.

On the other hand, at station 5, the rock to be identified by students, limestone, appears in some places with a slightly dirty appearance (Figure 8), which may have contributed to the difficulty in identifying it.


**Figure 8.** Station 5 overview, where it is possible to see limestone with a dirty appearance.

Regarding their characteristics, the rocks that make up the field trip do not present a high degree of cognitive difficulty for the 7th grade students, which is why these students were able to better identify the rocks during the field trip, compared to younger students. However, the clues left by the narrative character were always adapted to students' scientific knowledge and, therefore, they were different for the 7th and 5th graders' respective field trips. So, although the clues are different, students should be able to, at least, know which rock to identify even before they tried to identify it in a monument.

It was also possible to verify that most of the students correctly identified the geographical location of the stations of the field trip, although this fact may have resulted from the development of the field trip itself, in which, sometimes, the researcher had to direct students to the correct location of stations. On the other hand, in the case of station 1, the one that most students correctly identified, the clue to the station was provided in the phase before the field trip, which would have given some time for the students to discover its geographical location. Station 5 of the field trip was the one with the highest number of incorrect identifications. This fact may be related to the degree of difficulty associated with identifying the geographical location of this station. Remember that the clue for this station was the music from which the students had to identify its composer, determine if the city of Aveiro had any tribute to that composer and, from there, identify the geographical location of the monument. Thus, it was necessary to discover a set of information sequentially, which may be considered difficult for these students. However, the students who answered the final questionnaire considered the clues easy to interpret. In this regard, it should be noted that during the field trip students constantly approached the researcher to help them in the interpretation of the clues, which indicates that this task was the one that, during the field trip, presented the most difficulty. Thus, the results obtained with the final questionnaire of the activities do not coincide with the observations made by the researcher during the field trip. On the other hand, the existence of higher rates of wrong answers in the stations located at the end of the field trip may be related to some fatigue on the part of the students, since the field trip lasted 90 min.

From the above, it is possible to say that these students generally demonstrate some skills in the area of scientific, technical and technological knowledge, since, for example, they generally correctly identified the rock samples that were part of the field trip.

Finally, with regard to the category of attitudes related to group work, it was found that students, in general, respect some rules of group work, but demonstrate a high lack of autonomy. Despite this, in younger students, respect for the rules of group work is less developed, which may be related to the systematic and articulated work that is necessary in this dimension of competencies. This absence reveals that these students may not have some competencies in the area of personal development and autonomy, which makes participation in activities like those involved in this research difficult.

### *4.3. After the Field Trip*

The main result obtained in this phase was the lack of student participation in the Campus platform, which may be due to several factors.

First, the contacts established by the researcher in order to encourage students to participate, given its importance for this research, may show a lack of interest on the part of students for activities outside the formal context to which they are accustomed and, perhaps, for projects with activities of this nature. In addition, the very type of strategy adopted by the researcher on the Campus platform may not have contributed to the participation of young people. Initially, it was expected that the collection of puzzle pieces and badges would be enough to attract students to use the platform, which did not happen. In this sense, in the second research cycle, we tried to encompass other types of online activities. However, the activities that the researcher considered interesting may not have been interesting for the students. It may also have happened that the guidelines given by the researcher to the students during the previous phases were not understood by the students. As the researcher verified in the phase before the field trip, it is a lot of information, some with a lot of detail, for the students to process in the time available. Participation in this phase was, in turn, voluntary, unlike the previous ones. This part of the activities may have been seen as extra classroom work without any repercussions in terms of evaluation, namely with regard to the Campus platform itself, which would constitute a new platform to learn about and explore. The results from the final questionnaire showed that students may consider this platform difficult to use and, therefore, they would have to first learn how to use it, which did not happen. The very limitations of technology to which children are generally subject can also condition their participation, since it is not reasonable to leave children free on a computer in activities that require search on the Internet [64]. In addition, the very degree of difficulty associated with the tasks to be carried out on the Campus platform may have conditioned the participation. According to several researchers [64,65] activities, including their level of difficulty, must be suited to students' abilities, namely their cognitive and emotional development. Students become annoyed if activities are too easy while difficult tasks cause them to fail and feel frustrated. In this regard, it should also be noted that young people tend not to use computer platforms that they find difficult to use [62,63]. In this sense, the research should have included initial activities guided by the researcher in order to familiarize students with the Campus platform.

On the other hand, despite students having mentioned, in the initial questionnaire, that they have good or excellent knowledge regarding Internet search, what happened during the field trip was exactly the opposite. The selection of search terms itself is limited. Participation in transmedia activities implies, in turn, some degree of autonomy, advanced media literacy and digital skills to interpret and process information from different sources [64], which the students involved in this study may not have yet developed and which may have led to their withdrawal.

## 5. Conclusions

Regarding the research question, "What are the contributions of the proposed transmedia activities for the development of thinking skills and the mobilization of students' scientific knowledge?", it can be concluded that the inclusion of digital technologies in the performance of certain tasks can favor the development of competencies in this area, namely in Internet search. It should be remembered that on the day of the field trip, all students knew the geographic location of the first station, which they would have discovered through an Internet search. As for the mobilization of scientific knowledge, it is concluded that, in fact, young people have to do it to perform certain tasks, such as macroscopically identifying rocks, previously studied in the classroom, during the field trip. In this regard, it should be noted that most of the students involved in this research were able to identify the rock samples present at the field trip stations through their macroscopic observation. However, few students perceive the importance of scientific knowledge for their daily lives and, therefore, are still unable to be aware of issues, in this case of a local scope, involving geosciences. On the other hand, the activities developed have the potential to contribute to the development of interaction and thinking skills, for example during the field trip, since the students had to decipher, in a group, the clues left by the main character of the narrative.

In this study, the students' lack of habit for online participation in school-related activities emerged. Although currently, due to the COVID-19 pandemic, students are somewhat more familiar with digital technologies, at the time of the implementation of this research, this type of technology was very little used. On the other hand, according to several studies [4,59], young people preferentially use the Internet on their mobile phones for activities related to entertainment. Activities like uploading content and sharing hashtags are unfamiliar to students and needed in transmedia activities, which conditioned participation in this study, since transmedia involves active participation in order to contribute to the narrative itself.

The absence of certain digital skills on the part of students is also a point that conditions participation in projects such as the one portrayed in this research. However, the activities have the potential to contribute to the development of such skills, since there is a certain time for students to search for the information. As mentioned earlier, in the field trip all students knew the geographic location of station 1.

In general, students actively participated in the different tasks of the first two phases of the activities. However, it was found that they are not very autonomous, which may also have led to their withdrawal in the phase after the field trip. Students are generally used to following instructions provided by teachers, which did not happen in this research and may also have led to their withdrawal. On the other hand, the active participation in the phases before the field trip and field trip seems to indicate that all phases should have been mandatory.

In short, if we cross the analysis carried out on the results from different data collection instruments, it is possible to infer that the students showed some competencies in the areas of interpersonal relationships, information and communication and scientific, technical and technological knowledge. It was not possible to determine the level of competencies in the area of critical thinking and creative thinking, since the students did not participate in the tasks that were intended to verify the existence of certain competencies.

From the above, the principal aspects that may have conditioned the research are related to lack of time to provide information throughout the activities, instead providing all the information in the beginning, students' lack of interest for activities outside school, students' lack of autonomy and digital skills and the degree of difficulty associated with the clues. The information provided to students should be more detailed and provided in a more guided way. On the other hand, the formulation of the clues should also be improved, since this was the aspect in which students showed more difficulties. The clues should be very specific and direct students to the exact location to be observed, for instance, with GPS coordinates. On the other hand, to make it more attractive to students, they should be provided using, for instance, QRcodes or augmented reality applications. In addition, the lack of previous studies using transmedia in Geosciences education prevented the comparison and there were no studies on which to base the construction of this study's activities. As a final remark, we emphasize the potential of this type of activity to innovate and diversify school resources, using digital technologies and group work framed in field trips, very important in Geosciences, which can improve students' skills in areas related to citizenship.

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