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Teaching Strategies Mediated by Technologies in the EduLab Model: The Case of Mathematics and Natural Sciences

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Abstract

The EduLab model is a “new” educational model that integrates technologies in educational contexts comprising full equipped classrooms with attractive and easy-to-use technological resources. This model tries to promote a dynamic and more effective teaching and learning process. For this purpose, the model provides teachers training and monitoring in order to encourage innovative pedagogical formats, such as collaborative work, flipped classroom and research-based learning (Pombo, Carlos, & Loureiro, 2015). The current article intends to characterize and analyse the developed teaching strategies with the use of the available technologies, carried out in the subjects of Mathematics and Natural Sciences in a fifth grade class at the Gafanha da Nazaré School Grouping (Aveiro, Portugal). In the Natural Sciences subject, technologies were used, particularly, to support the resolution of work proposals. The research-based learning and collaborative work were implemented as a way to develop skills and “acquiring” knowledge by the students. In some Natural Sciences lessons, flipped classroom method was implemented with significant gains for the students’ learning. In the Mathematics lessons, technologies were especially used to support the resolution of work proposals and oral exposition by teacher. Attending to the specificity of this subject, the implementation of innovative strategies was less frequent.

Introduction

The current paper is part of the doctoral project in Multimedia in Education (University of Aveiro, Portugal) of the first author, being the second author her supervisor. This project aims to evaluate the impact of the EduLab model on basic education and is integrated in the AGIRE project (Apoio à Gestão Integrada da Rede Escolar - Support for School Network Integrated Management), a partnership between the University of Aveiro (Portugal), the Consortium E-Xample (which gathers 26 companies in the areas of education and/or technology) and the Gafanha da Nazaré School Grouping (Aveiro, Portugal) (AEGN).

The AGIRE project was created to support the implementation of the EduLabs project in AEGN. The EduLabs project intends to lead on, as a new model of technologies integration in education, comprising not only the availability of various technological resources, but also, teachers’ training and monitoring the integration of technologies in classrooms as well as resources optimization. It is a pilot project that, in the academic year 2014/2015, was implemented in ten groups of Portuguese schools, among them the AEGN. In this academic year, twelve AEGN teachers were involved as well as five courses of three education cycles, totalizing around 100 students. This paper aims to characterize and analyze the teaching strategies implemented using technologies, in Mathematics and Natural Sciences’ subjects, in a fifth grade class of the AEGN EduLab. In order to achieve this aim, data were collected by the use of survey techniques (interview) and observation (grids and researcher book note).

This chapter begins by presenting the theoretical foundation related to the above mentioned thematic, which focuses essentially on the principles of the EduLab model’ innovative teaching strategies and the use of technologies in Mathematics and Natural Sciences subjects. In the following chapter, some methodological considerations in terms of data collection techniques and instruments will be presented, as well as the respective techniques and analysis. Then, the results regarding the frequency of the use of available technological resources in the AEGN EduLab and the objectives associated with its use will be presented. In chapter “Results” some considerations will come out about the implemented teaching strategies with the use of technologies in the Mathematics and Natural Sciences subjects and their impact on the teaching and learning process. Finally, the main conclusions and recommendations for future work will be presented.

EduLab Model

The recognition of the potential of technology in an educational context, have lead that, in recent years, Portuguese schools have been implementing various initiatives and programs to support the integration of technology in the teaching and learning process. It is possible to highlight, for example, the Minerva project, Nónio-Século XXI program, “Equipa de Missão Computadores, Redes e Internet na Escola” (Mission Team Computers, Networks and Internet at School) and “Plano Tecnológico da Educação” (Technological Plan of Education), among others.

The Minerva project, which took place between 1985 and 1994, was the first major initiative to promote the use of technologies in educational context in Portugal. This project had as main goals the inclusion of ICT (Information and Communication Technologies) subject in the curriculum, the use of ICT as an auxiliary tool for teaching other subjects and the training of trainers and teachers (Ponte, 1994). In 1996, the Nónio-Século XXI program continued the Minerva project and intended to promote the continuous training of teachers, the production of educational software and the encouragement to collaborative network. On the other hand, Nónio-Século XXI program sought to support the development of school projects in partnership with higher education institutions and training centres, designated “Competence Centres”. These centres acted as promoters for reflection and research on integration of the ICT in education and supported the preparation and implementation of projects presented by schools (Rego, Gomes, & Andrade, 2000; Despacho 232/ME/96 de 29 de outubro).

In 2005, the Portuguese Ministry of Education established the “Equipa de Missão Computadores, Redes e Internet na Escola” which had as purpose to “design, develop, implement and evaluate mobilizing and integrative initiatives in the use of computers, networks and Internet in schools and in the teaching and learning processes” (Despacho 16 793/2005 de 3 de agosto, p. 11099). In 2007, the “Plano Tecnológico de Educação” was implemented whose basic goals were: to ensure the technological equipment of schools, to support the development of digital content, to focus on teachers training in ICT and to enhance the dissemination of good practices (Resolução do Conselho de Ministros 137/2007 de 18 de setembro).

Currently, it is being developed a new educational model that, by the use of technology, seeks to respond to the needs and interests of future generations, the EduLab model.The EduLab model, whose name comes from the combination of the words "education" and "laboratory", intends to guide a new model for technologies integration in educational contexts. In addition to provide technological resources, this model predicts teachers’ training and monitoring, in order to ensure that the use of technologies is made of a pedagogical and motivational way, with advantages for the teaching and learning process.The EduLabs constitute experimental teaching and learning ecosystems, equipped with technological resources to be used in a pedagogical way, seeking to promote innovation in the following topics: *i)* development of digital literacy of those involved in the project; *ii)* teachers’ training and monitoring the integration of technologies in education process; *iii)* implementing innovative education practices; *iv)* educational community's involvement in the project; and *v)* the development of digital contents (Pombo, Carlos, & Loureiro, 2015) (Figure 1).

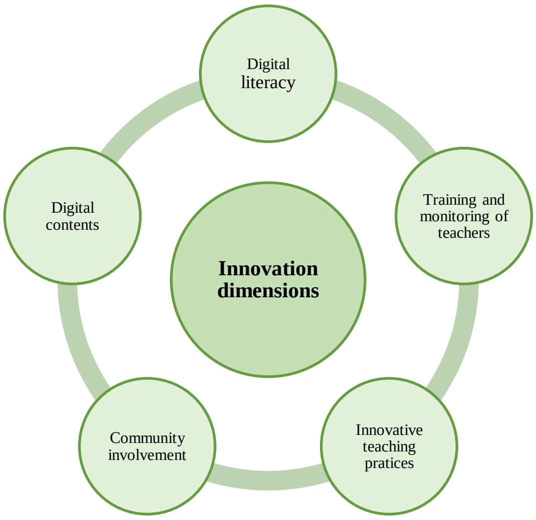

Figure 1. Dimensions of intervention and innovation of the EduLabs project

Classrooms used in the EduLabs project context are equipped with computer, interactive whiteboard and projector. Both students as teachers involved in the project have a laptop/tablet with integrated textbooks (in digital format), having access to an Open Educational Resources platform (OER), e-learning software/classroom management (Mythware) and Internet (see Figure 2).

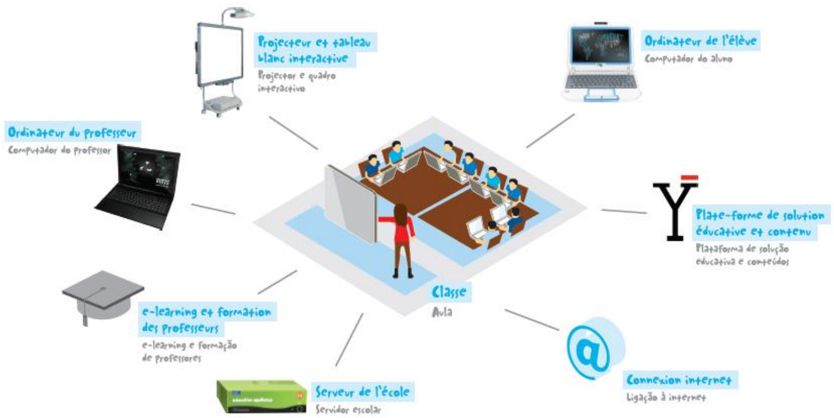

Figure 2. Available resources in the EduLab model (adapted from E-Xample, 2014)

In AEGN EduLab, first level students, particularly of primary education (6-10 years), use a laptop, while higher levels of education use the tablet as a device to support teaching and learning. In both cases, the use of resources is based on a "one to one" relationship: a computer/tablet for each student.

Of the various available devices, tablet is the one that, according to Dixon and Tierney (2012), best suits the philosophy "1-to-1 learning" and, consequently, the BYOD (Bring Your Own Device). The tablet allows people to create content, collaborate and communicate. When equipped with a pen, the tablet is totally appropriated for learning because it offers a wide range of educational opportunities, such as converting small notes to texts and writing chemical and mathematical formulae. Dixon and Tierney (2012) argue that the purpose of the "1-to-1 learning" is to create more autonomous learners, confident and with ability to learn throughout life.

The BYOD philosophy increases the opportunities of learning and facilitates the development of 21st century technical skills, as well as soft skills, such as communication, collaboration and creativity (European Schoolnet, 2015). "BYOD" turns learning more active and engaging and promotes the development of creative, intellectual, conceptual and analytical thinking, as well as understanding and connecting ideas (Dixon & Tierney, 2012). The European Schoolnet (2015) also argues that the implementation of BYOD improves the teaching quality since it allows teachers to provide differentiated learning experiences that meet students' specific needs and learning styles.

On the assumption that digital content use and access to applications and teaching platforms promote an interactive and motivating learning environment, the EduLab model recommends technologies to be associated with teaching formats and appropriate actions in order to provide a more efficient and dynamic teaching and learning process. With the EduLabs project it is intended to develop a work of continuous improvement in the relationship between pedagogy and technology, by frequently assessing their impact. Thus it seeks to optimize, whenever appropriate, resources and pedagogical practices.

Verdú and Lorenzo (2010) underline that the learning styles of students, the kind of skills and competences to be developed, the content and the available resources are factors that may determine the success of teaching and learning implementation strategies. The authors point out that the use of diverse strategies is advantageous and that technologies can facilitate the implementation of these strategies.

In order to ensure that the technology has a positive impact in the teaching and learning process, the EduLab model provides, for teachers involved in the project, training in a b-learning system, in two phases: initially, a 15 hours training course with technological nature that focuses on the use and the potential of available technologies; and, subsequently, a 64 hours training workshop with pedagogical character, where teachers discuss relevant strategies for teaching in the project context (Carlos, Pombo, & Loureiro, 2014).

As Prensky (2005) affirms, even if access to technology in the classroom is guaranteed, this is not a sufficient condition for teachers to incorporate into their teaching practice. It is necessary that teachers are predisposed to do so, putting technologies at the service of a higher quality educational process, which implies a change in the school practices and the adoption of innovative teaching practices. In this sense, teachers training referred to the EduLab model is based on two main objectives: *i)* to promote the integration of technology in the classroom, creating learning enhancers environments; and *ii)* monitoring activities implementation using technologies in the classroom with students (Carlos, Pombo, & Loureiro, 2014). Thus, teachers training and monitoring emerges as a way of encouraging the implementation of innovative education practices, namely, flipped classroom, collaborative work and research-based learning (Pombo, Carlos, & Loureiro, 2015).

Innovative Teaching Strategies Mediated by Technologies

There are several studies and authors that set out the potential of using technologies in educational contexts, reason why, in recent years, it has been encouraged its integration into the teaching and learning process. The positive impact on a motivational level and the support of 21st century skills development, such as communication, collaboration, critical thinking, problem solving and creativity, are some of the benefits which have been recognized (Balanskat, Blamire, & Kefala, 2006; Jonassen, 2007; Schrum & Levin, 2009).

European Commission communication *Opening Up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources* (2013), highlights the fact that technologies allow to extend the learning contexts beyond the classroom: "open technologies allow All individuals to learn, Anywhere, Anytime, through Any device, with the support of Anyone" (p. 3). In addition, Casa Nova (2014) claims that the technology-mediated learning is a student-centered learning that promotes the development of essential skills to academic and/or professional path, which could not be developed without technologies use. The author suggests a diagram (Figure 3) that reflects the state of maturity of the use of technology in an educational context, where it highlights the focus on learning rather than technology.

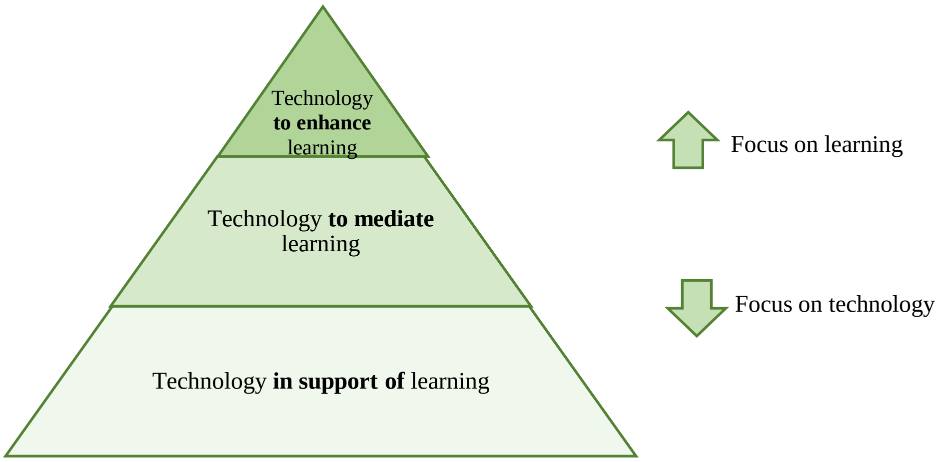

Figure 3. State of maturity of the use of technology (adapted from Casa Nova, 2014)

Thomas and Knezek (2008) state that the implementation of educational practices that promote the integration of technologies depends, on one hand, on the access to technological resources and, on the other, the skills that the teacher has to facilitate students' learning through the use of these resources. The British Educational Communications and Technology Agency (BECTA, 2009) adds that the teacher professional development is the key for teachers to use technology effectively and that the appropriate use of technologies can enable "spare" time.

Ruivo and Mesquita (2013) state that an "aseptic and brainless use" of technologies in the classroom, "without any pedagogic-didactic contextualization", is a "waste of investment" (p. 12). In this context, it makes sense that, as in the EduLab model, teachers are trained and supervised in the process of integration of technologies in their classrooms, promoting, whenever possible, the adoption of innovative teaching practices. The flipped classroom methodology, the collaborative work and the research-based learning are some of the methodologies that may be highlighted hare and that will be briefly exposed afterwards.

The flipped classroom methodology, as its name suggests, is based on the inversion of the tasks that are usually made at home and school. Thus, the tasks that are usually made in the classroom, such as topic exposure, for example, are made at home, independently by the student using a learning resource, for example, a video, suggested by the teacher. On the other hand, the tasks that normally are performed at home, as the consolidation of a theme and the resolution of exercises, for example, are to be held in the classroom (Bergmann, Overmyer, & Willie, 2011). So, in the classroom, it is favored students' interaction, collaborative work, questions, debates and problems solving related to those contents "studied" at home. The implementation of this teaching strategy raises a change in teacher and students' role. The teacher stops being assumed as a knowledge transmitter and starts to guide the students in a process in which they are held accountable for their learning, assuming a more active role (Bergmann, Overmyer, & Willie, 2011; Bergmann & Sams, 2012; Tucker, 2012).

The collaboration turns learning into a social activity (Maier & Warren, 2002), which is characterized by the involvement and active participation of the students in achieving a common goal (Seabra, 2013). According to Verdú and Lorenzo (2010), collaborative learning allows students to create synergies among themselves that may result in a better performance of all, as well as lead to better learning outcomes. In addition, the friction between students is reduced and there is a higher motivation. The authors synthesize a set of benefits of implementing collaborative learning. For example, they highlight that students have more favorable attitudes for learning and the cognitive conflicts that emerge from the group work can enrich comprehension. In this sense, the collaborative and collective construction of knowledge can be reflected in a cognitive level, with gains in learning, but also in an affective level, which may result in increasing motivation and feelings of satisfaction (Pombo, Loureiro, & Moreira, 2010; Pombo & Talaia, 2012).

Verdú and Lorenzo (2010) underline that any imbalance in the distribution of tasks may be a disadvantage for the implementation of collaborative learning. Based on studies of other authors, Verdú and Lorenzo (2010) point out other factors that might constitute disadvantages in collaboration, in particular, the fact that this work can result only in a mere cooperation or some members of the group in order to persuade the others to carry out tasks in their own way. In addition, the authors state that without proper guidance by the teacher, sharing answers and tasks within the groups can be reduced, by minimizing the advantages of collaborative work.

The research-based learning seeks concepts, attitudes and values construction, where teacher promotes learning situations in which the student participates actively in the construction of their knowledge (Cachapuz, Praia, & Jorge, 2002). The perspective of research-based learning values the students' previous ideas and error situations and argues that the methodological and pedagogical resources strategies must provide students the integration of concepts, as well as the analysis and reflection of their own methods of work (Lucas & Vasconcelos, 2005).

Cachapuz, Praia and Jorge (2002) point out four principles of the research-based learning perspective: *i)* the inter and transdisciplinarity in order to understand the world in its entirety and complexity; *ii)* approach to daily problem situations, that could allow to reflect on the processes of science and technology and their relationships with society and the environment, promoting informed and responsible decision-making, as well as attitudes and values development; *iii)* methodological pluralism, at the work strategies level; and *iv)* educational assessment, which is intended to be regulatory and guiding.

The research-based learning strategy assumes major importance in the context of the science education and seeks to ensure that lessons are useful in students' personal and social development, future citizens of a, democratic, technologically developed and open society (Cachapuz, Praia, & Jorge, 2002).

Technologies in Mathematics and Natural Sciences' Subjects

The document "Organização Curricular e Programas" (Curriculum Organization and Programs) (Ministry of Education, n. d.), set for fifth and sixth grades Natural Sciences subject, acknowledges that the scientific and technological character of current society requires an adequate response from the school. In this sense, school must provide students with scientific and technical knowledge and attitudes to ensure that they will apply this knowledge in the future. Thus, Natural Sciences subject should allow students development and their understanding of themselves and the world around them; the development of concepts, skills and attitudes that promote zest for knowledge and discovery; and the development of understanding science as a means to solve real-life problems, including the technological character.

Costa, Rodriguez, Cruz and Fradão (2012) stress that the use of technologies to mediate methodologies, which respond to science education specificities, promotes the development of scientific expertise at the knowledge, skills and attitudes levels. With regard to Mathematics, Costa et al. (2012) refer that research underlines the importance of integrating the technologies in teaching the subject, whose benefits are reflected in the development of autonomy, curiosity and "cognitive contact" with Mathematics; in the improvement of the patterns identification, as well as the connection between mathematical ideas; in increasing opportunities for real data exploration; and access to visual representations to mathematical ideas. The authors state that, currently, there is a wide range of technologies that can be seen as mediating tools of Mathematics' teaching and learning processes, leading to the development of skills, knowledge and mathematical skills. They highlight, for example, Internet, dynamic geometry software, the spreadsheet and the programs based or inspired in the programming language LO GO.

PISA 2012 report from the Organization for Economic Co-operation and Development (OECD, 2014) points out that, in general, students who often use the technologies in the Mathematics classroom believe that their teachers implement more effective strategies, including structuring practices, student-oriented practices, formative assessment and cognitive activation. This report stresses that teachers who are well prepared to implement student-oriented teaching practices (including individualized learning, group work and collaborative project work), are more willing to integrate the technologies in their classes, whenever the necessary resources are available.

Method

The doctoral project that is the basis of the presented paper is a mixed nature case study, which aims to assess the impact of the EduLab model in the educational process in basic education. Particularly in this paper, it is intended to characterize and analyze the teaching strategies implemented in the context of the AEGN EduLab, in the fifth grade class and in Mathematics and Natural Sciences subjects.

The class comprises twenty students, twelve (60%) males and eight (40%) females, whose ages, at the beginning of the academic year, were between nine and twelve years old. In this class there are included two special educational needs students. There are also two students with retentions in the fifth grade, in the previous academic year, and a student with retention in the second grade.

In order to characterize and analyze the teaching strategies implemented in this class, in Mathematics and Natural Sciences' subjects, data was collected through the techniques of observation and survey. The researcher observed sixteen Mathematics and twelve Natural Sciences lessons, throughout the academic year 2014/2015, in a fifth grade class. When defining the methodological procedures, the researcher opted for the non-participant observation, since it is not expected to have interaction with the study object at the time of the observation (Carmo & Ferreira, 2008; Sousa, 2009).

However, during the investigation, it was considered appropriate to choose a participant observation in order to understand, with more detail, how the strategies were implemented and how was the impact among students, ensuring, however, the same rigor, objectivity and impartiality in the investigation. From the observation of lessons was filled an *online* form (http://bit.ly/2dSwsl8), common to all years of schooling and subjects in which the EduLabs project in AEGN was implemented. This form was created and validated by two members of the EduLab project of University of Aveiro. These observation and registration grids intended to identify the resources used, implemented strategies and objectives associated with the implementation of these strategies. On the other hand, the form allowed assessing the impact of the use of technological resources (and respective strategies) in the teacher, students, class management and learning. In addition to the lessons registration grids, the observation, also reflected in the researcher book note, assumed both descriptive and reflective character.

The data collected through the technique of observation was complemented with an interview to the Mathematics and Natural Sciences teacher, who teaches the two subjects in the involved class. The survey interview allows the investigator to interact with the respondent in order to collect descriptive data and additional information in his/her own language, allowing the investigator to intuitively develop a conception of how the person interprets the situation (Bogdan & Biklen, 1994; Coutinho, 2013). The main objective of this interview was to characterize the teaching strategies using the technologies implemented in Mathematics and Natural Sciences subjects in AEGN EduLab and the teacher's perspective on the teaching and learning process respective impact. In this sense, the interview was divided into 6 thematic blocks, shown in Table 1.

The teacher interviewed is graduated in Math and Sciences of Nature Teachers on Basic Education. She teaches for about twenty years, always in the fifth and sixth year, and, in the academic year 2014/2015, she was the Mathematics and Natural Sciences teacher of the observed lessons. The teacher believes that the integration of technology in education has several potential, both for teaching and learning, reason why she proved to be available to integrate the project in the AEGN EduLab. Throughout her career she made several training in educational technologies area, especially related to Mathematics.

Table 1. Thematic and specific objectives of the interview

Thematic blocks	Specific objectives
A. Professional characterization of the interviewee	• To characterize the academic career of the interviewee; • To characterize the professional experience of the interviewee; • To know the training course of the interviewee in the field of technology.
B. Integration in the EduLabs project	• To know the motivations of the interviewee to integrate the EduLabs project.
C. Teaching strategies that use technologies implemented in the classroom	• To know the technological resources used by the interviewee in her classes before and after joining the project; • To characterize the implemented teaching strategies using technologies in the classroom; • To identify the changes in teaching practice caused by the integration in the project.
D. Impact of the use of technologies in the teaching process	• To know the interviewee perspective of the impact of technologies in the teaching process; • To know the interviewee perspective on the contribution of technologies to the implementation of innovative teaching strategies.
E. Impact of the use of technologies in students and learning	• To know the perspective of the interviewee about benefits and disadvantages of the use of technology to students and the learning process.
F. Barriers to the use of technologies and to the implementation of innovative strategies in the classroom	• To identify barriers to the use of technology in the classroom; • To identify barriers to the implementation of innovative education strategies.

The data collected through the lessons registration grids, given their majority quantitative nature, were statistically target. On the other hand, the data collected through the researcher book note and by interview conducted with the Mathematics and Natural Sciences teacher, by their nature, were treated using qualitative content analysis. Table 2 summarizes the techniques, instruments, registration forms and data collection sources considered in this paper, as well as data analysis techniques adopted.

Table 2. Data collection and analysis

Data collection techniques	Data collection instruments	Registration forms	Data collection sources	Data analysis techniques
Observation	Researcher book note	Written notes by researcher	16 Mathematics' lessons 12 Natural Sciences' lessons	Content analysis
	Registration grids	Online form		Statistical treatment
Survey	Interview guide	Audio recording and transcription	Interview to Mathematics and Natural Sciences' Teacher	Content analysis

Results and Discussion

This chapter presents the results regarding the frequency of use of available technological resources in the AEGN EduLab and the objectives associated with its use. There are also some considerations about the teaching strategies implemented with the use of technologies in the Mathematics and Natural Sciences subjects and their impact on the teaching and learning process. This description is accompanied by a reflection that takes into account the data collected in the researcher book note and the interview to the Mathematics and Natural Sciences teacher.

It should be noted that due to rounding, the sum of the relative frequencies of some parameters of the graphs presented in figures 13, 14, 15 and 16 apparently do not make 100%, it can have a maximum deviation of 1%.

One of the basis of the EduLab model is equipping classrooms with technological resources, to be used for motivational and pedagogical purposes. As previously mentioned, AEGN classrooms of the EduLabs project are equipped with computer, projector and interactive whiteboard. In addition, the teacher and the students in the class have a tablet with integrated digital books and access to Open Educational Resources (OER) of Leya Platform and e-learning software/classroom management (Mythware). In the following paragraphs, the results related to the frequency of the use of the available resources will be presented.

In Mathematics, it is shown a very frequent use of computer, tablet and projector in 88% of the observed lessons (value that corresponds to 14 of the 16 observed lessons). Less frequent is the use of digital books (50%, 8 lessons), the interactive whiteboard (38%, 6 lessons), OER and Mythware software (25%, 4 lessons) (Figure 4).

In Natural Sciences, there is a very frequent use of tablet in 92% of the lessons (value that corresponds to 11 of the 12 observed lessons) and computer and Mythware software in 75% of the lessons (9 lessons). Less frequent is the use of the projector (58%, 7 lessons) and the OER and the digital book (33%, 4 lessons). In Natural Sciences subject, the interactive whiteboard was used in an interactive way in only one lesson (Figure 4).

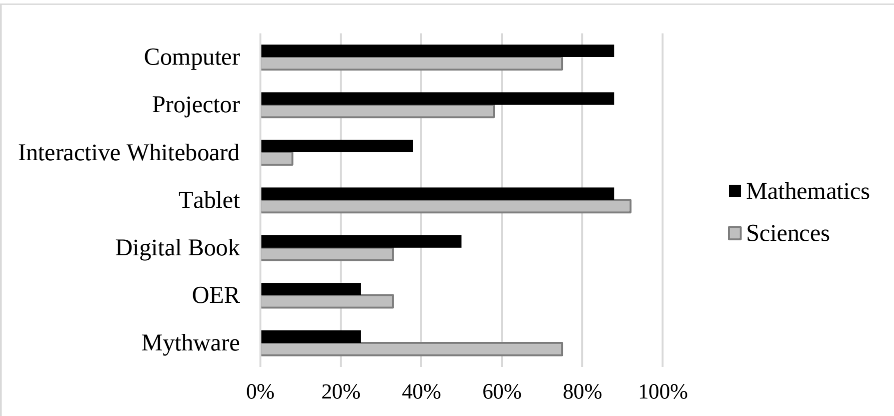

Figure 4. Technological resources used in Mathematics and Natural Sciences

The Mathematics and Natural Sciences teacher highlights the tablet importance in this project, since in a single resource, teachers and students can access various applications (programs, games, digital books, among others). In addition the tablet is a part of the available material in all lessons (which may be used where appropriate), each student has a tablet for himself and they can enjoy the tablet outside school too. This factor is, in the opinion of interviewed teacher, an advantage for students' learning, since it facilitates the revision and consolidation of knowledge, "in many ways, as many times as they wish, anywhere and at any time". Tablets have the books integrated in digital format and allow access to a platform of educational resources and Mythware software.

There are various advantages of educational resources used by the fifth grade class students, whose impact on the teaching and learning process was considered positive by the teacher interviewed. It offers a wide range of interactive activities, such as review tests and consolidation of knowledge, to carry out an automatic correction and the immediate feedback to students. This platform also includes a diverse set of resources that can be used to address and explore content, such as videos that support the implementation of the flipped classroom methodology. In addition to the resources being presented in a visually appealing way, the platform encourages communication between students and between them and the teacher, through a forum where materials and information are available (Figure 5).

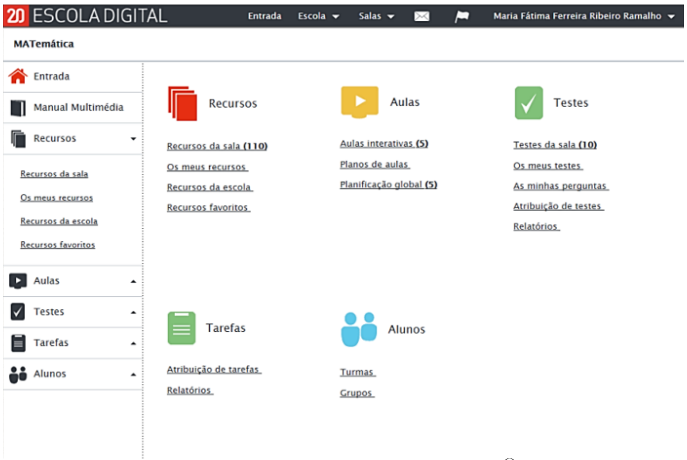

Figure 5. Platform of open educational resources (Leya®), used in the fifth grade

Along the observed lessons, the Mythware software (Figure 6) revealed many advantages at the level of file sharing, assessment and classroom management. It also allows control and monitor the students activities, such as sending/receiving files of any tablet which is connected and the creation of questionnaires, among many others possibilities. These questionnaires, which can assume assessment character, for example, allow the inclusion of different types of questions: single, multiple, alternative answer, true or false, gaps and open response. The software allows automatic correction of questionnaires and the immediate feedback for students and teachers. According to the Mathematics and Natural Sciences teacher, this feature constitutes an advantage for the teacher and higher motivation to students.

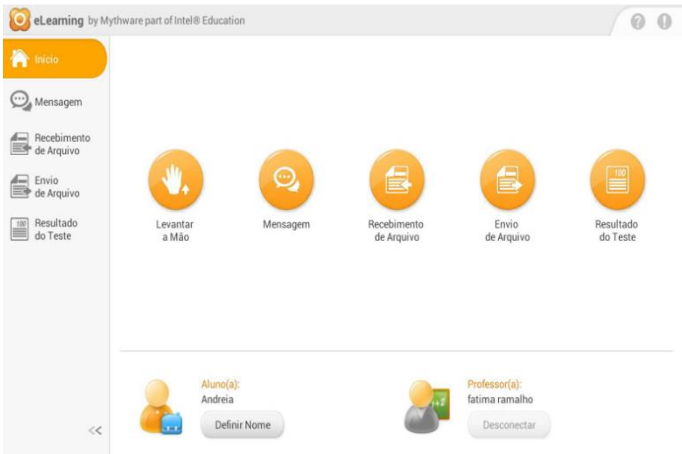

Figure 6. E-learning software and classroom management, Mythware

In addition to the resources presented in Figure 4, in Mathematics there were used presentations created by the teacher to explore content, in 44% of the lessons (7), scripts of work in digital form in 19% of the lessons (3) and worksheets in digital form in 13% of lessons (2). In 38% of the observed lessons (6) was still used the dynamic geometry software, GeoGebra (Figure 7).

In Natural Sciences, there were used working scripts in digital form and videos in 33% of the observed lessons (4), worksheets in digital form in 17% of lessons (2) and presentations created by teacher in 8% of lessons (1). The students resorted to the Internet in 25% of lessons (3) (Figure 7).

As evidenced in Figure 7, the software GeoGebra (Figure 8) was used in 38% of the Mathematics observed lessons. Initially, only the teacher, in exhibition or demonstration lessons, used this dynamic geometry software, for example, to differentiate lines, half-lines and lines segments.

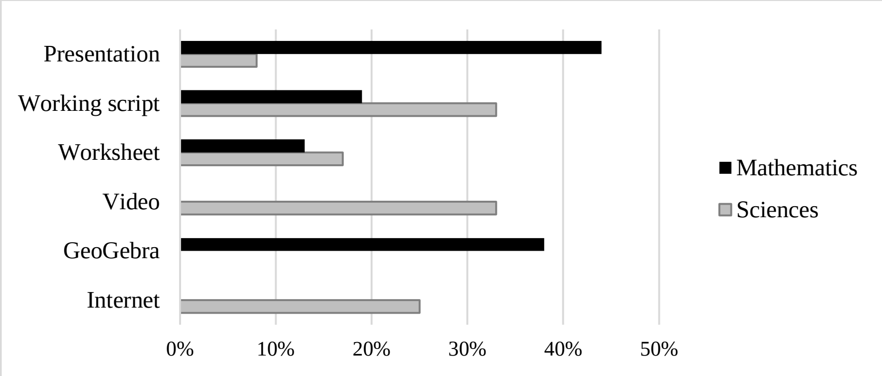

Figure 7. Resources used in Mathematics and Natural Sciences

However, it is noted that in 25% of the lessons, students, using a script, searched the properties of parallelograms and triangles and formulated the triangular inequality, using this software. It was found that, in the first lesson, students showed some difficulties in the implementation of the steps suggested in the exploitation script; however, progressively they showed higher level of autonomy and satisfaction in its use. For the teacher, the use of this software brought advantages because it allowed the preparation, in advance, the geometric constructions to exhibit to students along the lessons, saving time and providing dynamics in class. However, the teacher also emphasized the importance of the use of drawing material, characteristic of geometry, in particular, ruler, set square, compass and protractor, articulating, frequently, two skills: digital and manual.

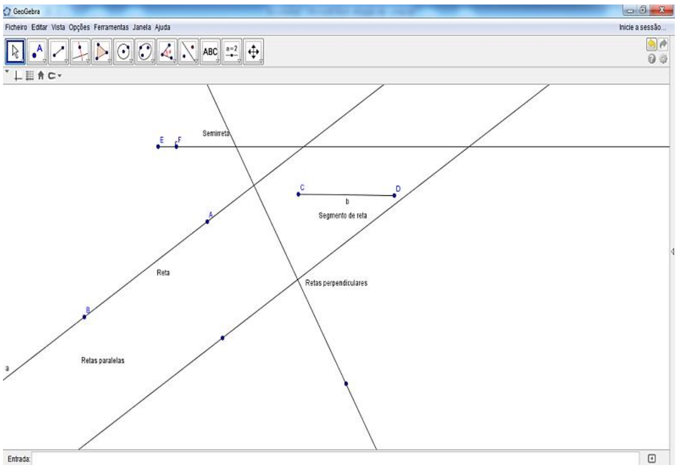

Figure 8. Dynamic geometry software, GeoGebra

In general, both in Mathematics as in Natural Sciences, the resources were considered adequate to the goals of the lessons. It was highlighted only a Math lesson (6%) in which the resources were considered unsuitable (Figure 9). That lesson was related to the thematic unit "Organization and Data Processing" by performing small statistical studies within the class. After establishing joint reflection between the teacher and the researcher, the resources were not considered fully suitable to the lesson' goals, because the potential of some available technologies was not appreciated in this context. For example, in the statistical study, instead of using "papers" it could be used the Mythware software. The teacher sent the question under study, with the four hypotheses, and the students answered using the software, which made it easier to count the students' answers. On the other hand, frequency tables, instead of being made in the blackboard, could be made on a worksheet, for example, that allowed students to reach a first graph's draft. However, despite not using technologies, students were equally motivated and involved in carrying out the tasks.

The EduLab model proposes that the objectives associated with the use of technologies should be translated into the benefits of teaching and learning process. In the following paragraphs, the goals associated with the use of technology in Mathematics and Natural Sciences will be presented.

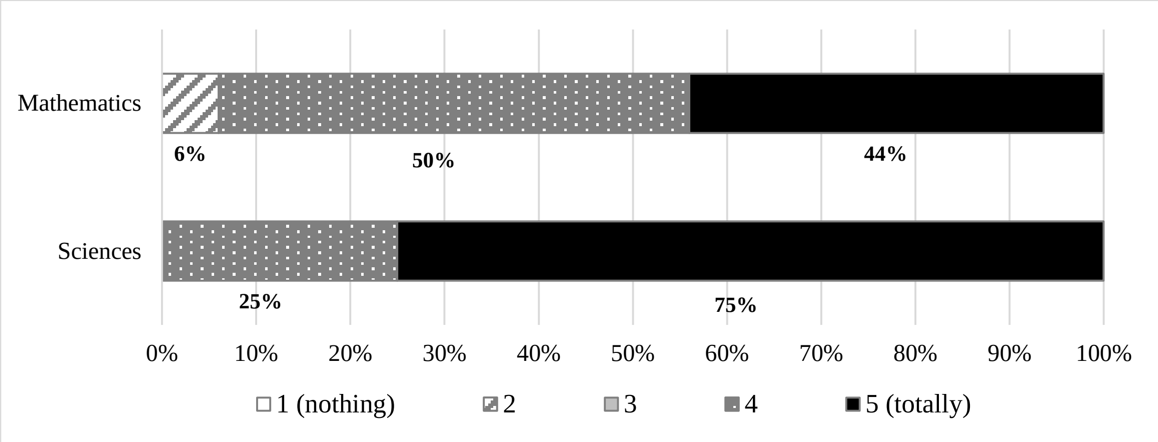

Figure 9. Suitability of technological resources to the goals of the lessons

In Mathematics, the use of technologies was mainly related with the work proposals resolution (75%, 12 lessons) and oral exposition of content by the teacher (50%, 8 lessons). There was still content production in 19% of the lessons (3), observation in 13% of lessons (2) and the revision of content in 6% of lessons (1) (Figure 10).

In Natural Sciences, the teaching strategies associated with the use of the technologies were more diverse. As in Mathematics, the technologies were mainly used to solve work proposals (50%, 6 lessons). However, there is research-based learning in 33% of lessons (4) and oral exposition by teacher, communication and evaluation in 25% of lessons (4). There was also the presentation of content by students in 17% of lessons (2) and observation and revision in 8% of lessons (1) (Figure 10).

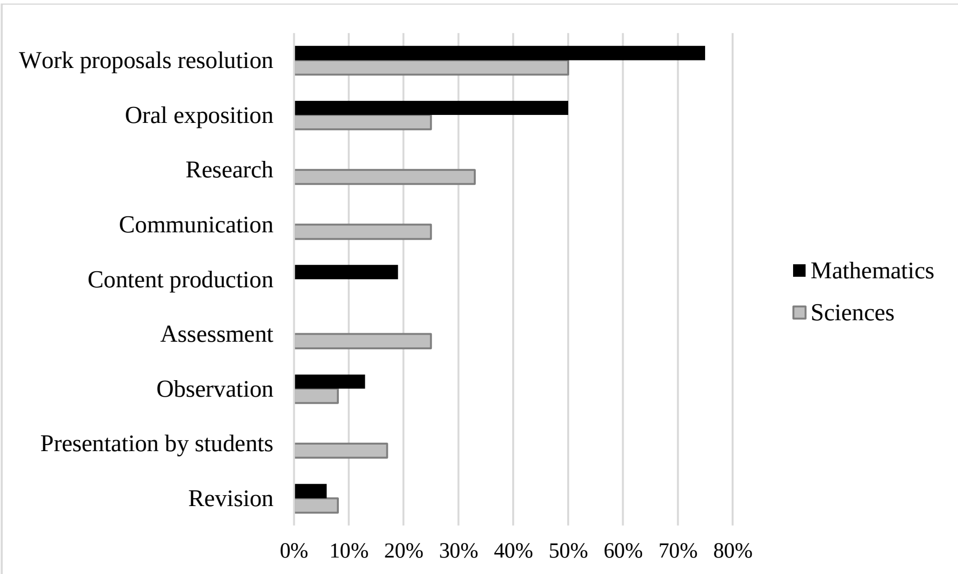

Figure 10. Objectives of technologies use

The EduLab model seeks to promote innovation through the teachers' encouragement to implement innovative teaching practices with the use of technologies, such as the flipped classroom methodology, the collaborative work and research-based learning (Pombo, Carlos, & Loureiro, 2015). The results on the frequency of implementation of these teaching strategies will be presented afterwards.

In Mathematics, there has not been implemented the flipped classroom methodology and research-based learning. The collaborative work was promoted in 25% of lessons (4), however, there is a higher percentage of observed lessons where individual work was promoted (75%, 12 lessons) (Figure 11).

In Natural Sciences, all teaching strategies advocated by the EduLab model were implemented: flipped classroom in 25% of the lessons (3); collaborative work in 50% of lessons (6); and research-based learning in 33% of lessons (4) (Figure 11).

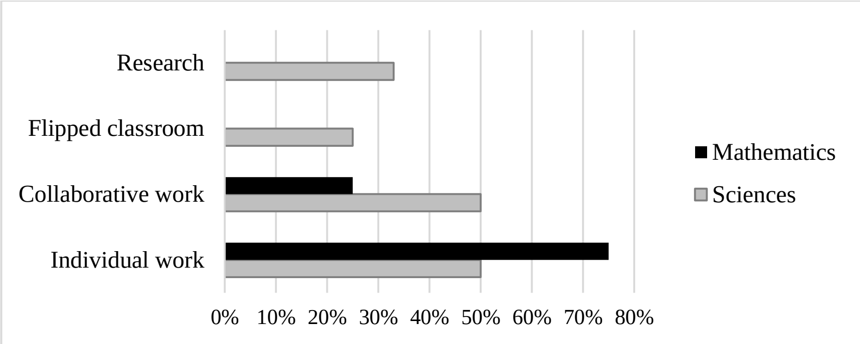

Figure 11. Teaching strategies implemented

The teacher interviewed believes that the research-based learning strategy fits better to Natural Sciences, due to the nature of the subject content, and recognizes that she doesn't know how to apply this strategy in Mathematics. Some Natural Sciences lessons had, as main goal, the exploration of content upon proposal of a research activity. However, the fact that students have the tablet with internet access, allowed that research was also used as a strategy for questions and curiosities that arose in the course of the lessons. The teacher says that the research-based learning makes learning more interesting and allows students to develop skills for the future. In class, the students were very excited and motivated to carry out search activities. These activities were, in some lessons, a quick and effective way to "extend" the content in the videos suggested by the flipped classroom methodology.

Also the flipped classroom methodology has not been implemented in the math lessons. The teacher says that, in her opinion, the flipped classroom methodology has a lot of capabilities and can be implemented in all subjects, with the exception of Mathematics. In this subject case, the teacher believes that students need to have the "teacher to explain first, repeatedly and in different ways". However, the teacher points out that the implementation of the flipped classroom methodology makes students have a more active role in their learning, so that they learn better.

The flipped classroom methodology was implemented in 25% of observed Natural Sciences lessons. It was found that in the first lesson in which the strategy was implemented, some students previously haven't viewed the videos or have viewed them entertaining, not paying attention to details, factor that affected the management and the dynamics of the class. Progressively, and with greater awareness and guidance by the teacher, by sending out questionnaires or scripts, it was found that the implementation of the strategy of flipped classroom promoted autonomous learning and the development of skills.

The collaborative work was proposed in 25% of the observed Mathematics lessons and 50% of Natural Sciences lessons. However, the teacher believes that in some lessons collaborative work was not effectively carried out since there was no involvement of all students. The teacher adds that the disposition of the students in the classroom is an important aspect in the implementation of this work methodology. In Mathematics, students are pair sited and forming groups involves reorganization of the disposal of the students, what causes some" lost" time in lesson. For this reason, in some Math's lessons students worked with their pair. The teacher believes that this kind of work has a positive impact on learning since students share ideas and reasoning. In the case of Natural Sciences, the implementation of collaborative work is facilitated by the fact that the students are always arranged in groups of four elements, causing, systematically, to interact and help each other, creating progressively work routines. The Mathematics and Natural Sciences teacher believes that sometimes the individual work leads to a large commitment of students.

The strategies implemented have been considered appropriate to the lessons goals. It is highlighted only a math lesson (6%) in which the teaching strategies were considered less suitable (Figure 12). This lesson was intended to carry out small statistical studies on class, and teaching strategies as well as the used resources were not suitable (see analysis of Figure 9), because the potential of technologies in this context had not been considered.

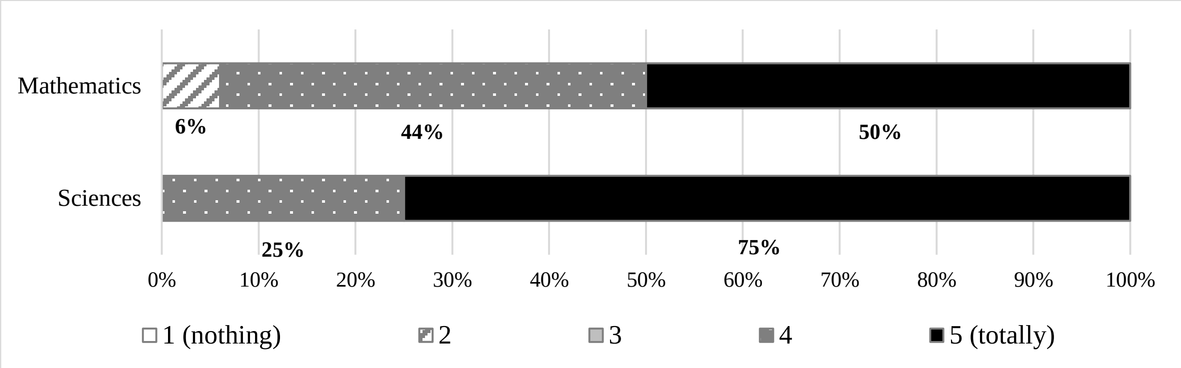

Figure 12. Suitability of strategies implemented to the lessons goals

In most of the lessons observed in Mathematics (Figure 13) and Natural Sciences (Figure 14) it was considered that the use of technologies and the implementation of strategies for teaching and learning mediated by technologies had a positive impact in terms of motivation, engagement, autonomy and participation of students.

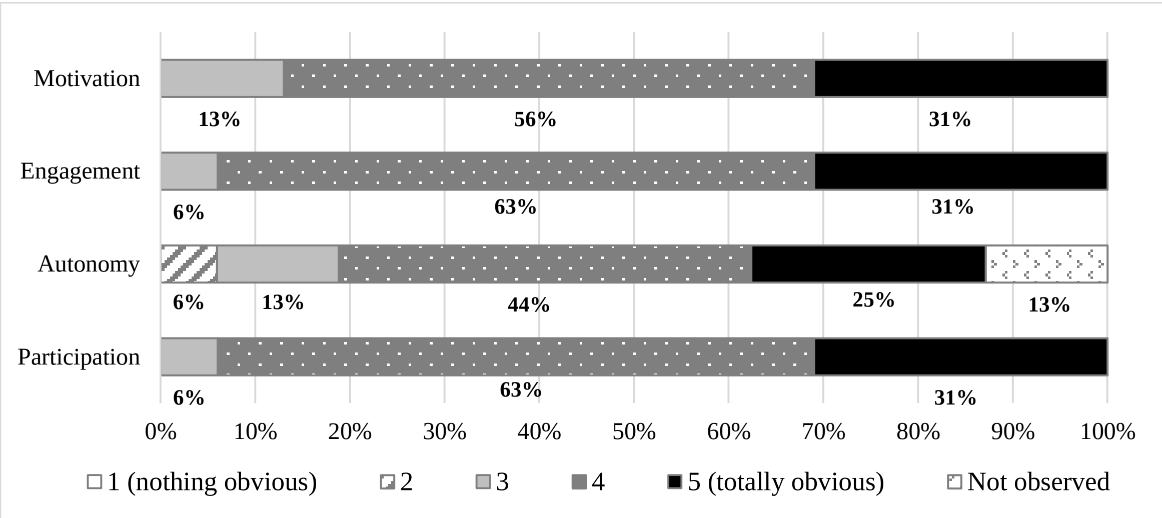

Figure 13. Impact of the use of technologies in the attitudes of students - Mathematics

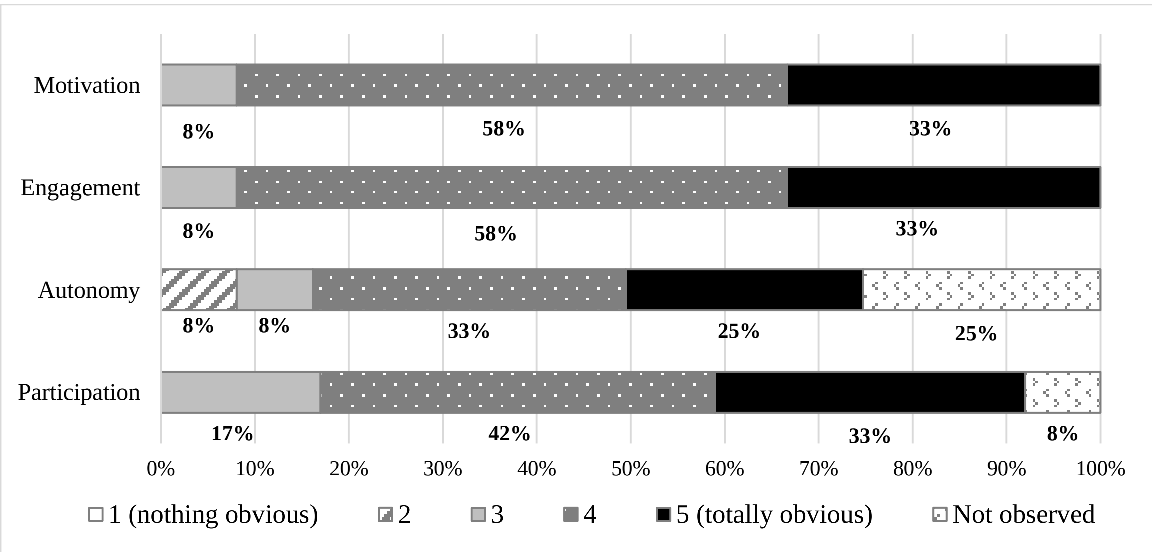

Figure 14. Impact of the use of technologies in the attitudes of students - Natural Sciences

Mathematics and Natural Sciences teacher claims that, in most of the lessons, students are enthusiastic, motivated and involved. However, the teacher stresses that technology by itself, may not be motivating and that it is necessary to combine the technology with motivating and challenging tasks.

The teacher believes that, at an early stage in using the technologies, lessons may not be as dynamic, and there are various situations that compromise the rhythm of the lessons, as the digital skills demonstrated by different students. According to the teacher, and according to the observation made by implementing strategies that often resort to technologies, students demonstrate progressively greater autonomy and dexterity in the use of resources, making it a more dynamic and productive lesson.

In the specific case of Mathematics, a subject in which it is common that students have difficulties, the teacher considers that using technology can help to overcome some difficulties since students are more motivated, more alert, interested and involved. It was found that the use of technologies and the implementation of technology-mediated strategies clearly contributed to the development of students' skills, in particular, digital skills in 75% of the observed lessons (12), specific disciplinary skills in 100% of the lessons (16) and problem solving skills in 63% of the lessons (10). Less clear was the development of communication skills, evident in only 25% of the lessons (4), and critical thinking, evident in 19% of the lessons (3). The goals of 50% of the lessons observed did not predict the development of creativity and in the others it was not evident that technologies had contributed to its development (Figure 15).

In most Mathematics lessons, it was not very evident the development of communication skills, critical thinking and creativity. That can be related with the teaching strategies implemented in this subject. According to the Figure 10, the use of technologies in this subject was mainly associated with the resolution of work proposals and teacher's oral exposition. In addition, as shown in Figure 11, it was not implemented research-based learning and flipped classroom, whose underlying principals may promote the development of the above-mentioned skills.

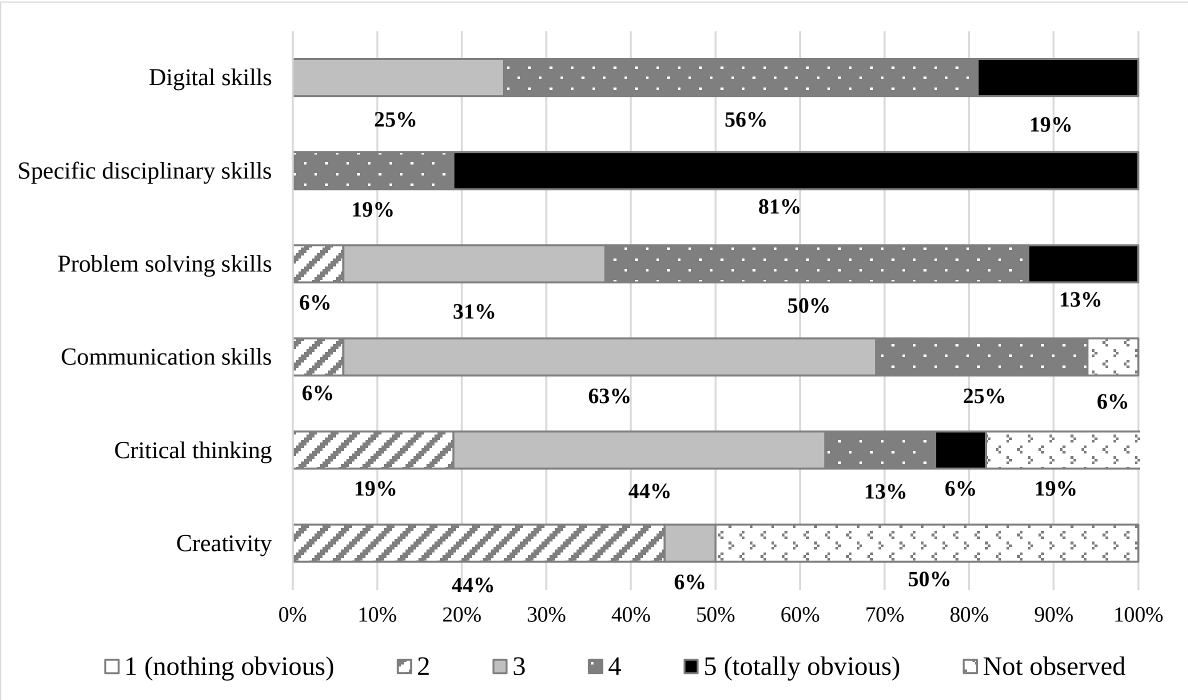

Figure 15. Contribution of technologies for the development of skills - Mathematics

In Natural Sciences it was considered that the implementation of technology-mediated strategies clearly contributed to the development of students' skills, in particular, digital skills in 84% of the lessons (10), specific disciplinary skills in 91% of the observed lessons (11), communication skills in 67% of lessons (8) and problem solving skills in 50% of lessons (6). Less clear was the development of critical thinking, evident in only 19% of the lessons (3). 58% of lessons (7 lessons) did not promote the development of creativity and, on the other lessons, as happened in Mathematics, it was not evident that technologies have contributed to the development of creativity (Figure 16).

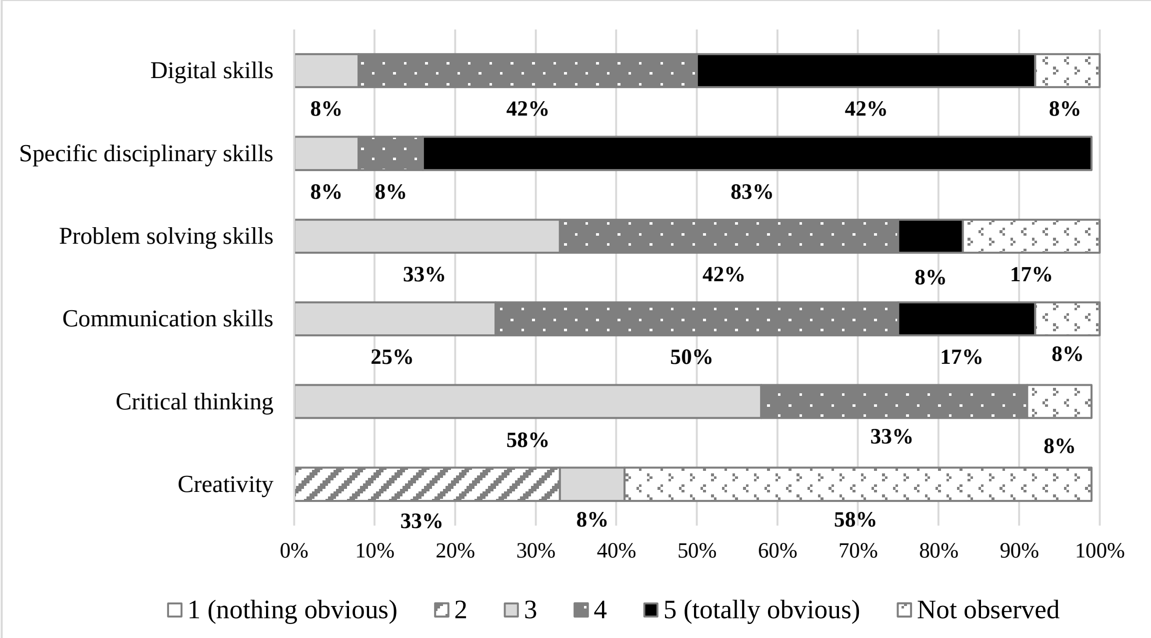

Figure 16. Contribution of technologies for the development of skills – Natural Sciences.

The teacher points out that one of her concerns in the preparation of teaching activities goes through planning activities to ensure that students have an active role in their learning, so that they learn best. She also considers that the technologies will give an important contribution to this end and says:

> "I don't know if the technologies encourage them to work more, however it seems that they lead to a more active role in students. […] I have no doubt that having an active role makes learning better because if the student produce, demand, search, conducts, try, definitely learns more and better. It may not be easy for them (students), but they will understand better, their learning is more significant and they retain better the information."

Despite the recognition of potential of mediated-technology strategies, the teacher mentions some obstacles to its implementation, in particular the exams (in the case of Mathematics), the extension of the curriculum, learning goals' requirement and teachers' workload. Moreover, the fear that the strategies do not result (in terms of teaching and learning benefits), the fact that the technologies can make the lessons more hectic and noisy and the fear of not controlling what students are doing individually, constitute, in the opinion of the teacher, factors that can lead to uncommon implementation of these strategies.

The teacher also says that technologies trigger changes in the practice of teachers, which allows a diversification of strategies and enriches the learning process to the extent that makes it possible to explore different learning styles. On the other hand, the fact of being able to get an answer at any time in any place values and facilitates teaching and learning processes, in the opinion of teacher. The teacher further indicates that the existence of technologies may not make a strategy to be innovative but acknowledges that technologies facilitate innovation in education, since they can be used to improve the quality of teaching and learning.

Conclusion

By providing technological resources, training and monitoring to teachers, the EduLab model aims to turn the teaching and learning process dynamic, efficient and motivating. In this paper, teaching strategies implemented in Mathematics and Natural Sciences class of fifth year involved in the EduLabs project were characterized.

Concerning the use of the available technologies in the context of the EduLabs project, both in Mathematics and in Natural Sciences, it is very frequent to use the tablet and computer and less frequent the digital books and OER. The frequency use of the tablet reflects the importance assigned by the teacher to this resource in the context of the EduLabs project. The fact that each student has his/her own tablet, allowing him/her to use it at school and at home, has translated into benefits for the teaching and learning process and, according to the teacher, allowed "All individuals to learn, Anywhere, Anytime, [...], with the support of Anyone", as stated by the European Commission (2013).

In Mathematics, the use of technologies is mainly associated with the work proposal resolution and teachers' oral exposition. It should be noted that, whenever relevant, the teacher used also the geometry software, GeoGebra, one of recommendations of Costa et al. (2012). The fact that it combines the use of digital tools, as drawing tools and measurement instruments will also meet the propose of the document "Programas e Metas Curriculares de Matemática no Ensino Básico" (Programme and Curriculum Goals of Mathematics on Basic Education" (Bivar, Grosso, Oliveira, & Timóteo, 2013). In this context, this document states that teachers should provide learning experiences that promote dexterity in the execution of strict geometric constructions and recognize mathematical results behind the different procedures.

In Natural Sciences, the goals associated with the use of the technologies were more diverse; however, for the most part, the technologies were used to solve work proposals. Diverse strategies might have a positive impact on teaching and learning and technologies may effectively facilitate this diversification (Verdú & Lorenzo, 2010).

With regard to the implementation of innovative education strategies suggested by Pombo, Carlos and Loureiro (2015), the results suggest significant differences in the subjects observed at the level of implementation and its frequency of implementation. In Mathematics there has not been implemented the methodology of flipped classroom or research-based learning. The collaborative work has been promoted in some lessons, whereas individual work has been promoted with a higher percentage. In Natural Sciences, all teaching strategies advocated by the EduLab model were implemented. In this subject, there have been a higher percentage of implementation of collaborative work when compared to Mathematics lessons. The teacher interviewed refers that she does not consider the implementation of the flipped classroom methodology and the research-based learning strategy in Mathematics, regarding the subject content and the fact that students are more dependent on the teacher to learn. In part, this conclusion is in accordance to Verdú and Lorenzo (2010) who mentioned that the learning styles, the kind of skills and competencies to develop and the contents of a subject, are factors that should not be neglected in the teaching strategies to adopt.

Despite not having been implemented in Mathematics, teacher recognizes the potential of flipped classroom methodology, including a more effective and active learning, which reinforces what has been documented in the literature. The collaborative work was implemented in both subjects. Facing the difficulties in promoting an effectively collaborative group work, the teacher chose to propose pairs collaboration. The teacher believes that pair work has a positive impact on learning, since students share ideas and reasoning. The research-based learning was implemented only in Natural Sciences, in some planned lessons, while in others, this strategy was implemented in an unplanned way determined by the conducted activities. Cachapuz, Praia and Jorge (2002) stated that the teaching strategy for research assumes major importance in the context of science education and seeks to ensure that the lessons are useful in students' personal and social development. Students are very enthusiastic and motivated when this strategy is implemented.

In both subjects, it was considered that the implementation of strategies for teaching and learning mediated by technologies had a positive impact in terms of motivation, engagement, autonomy and participation of the students. In addition, it was considered that the use of the technologies contributed to the development of skills, in particular specific disciplinary skills, digital skills and problem-solving skills. Along the lessons observed in Mathematics and Natural Sciences, it was considered less clear the contribution of the use of technologies for the development of communication (evident only in some Natural Science lessons), critical thinking and creativity.

The fact that, in most Math lessons, it has not been very evident the development of communication skills, critical thinking and creativity, that can be related with the teaching strategies implemented in this subject. In Mathematics, the use of the technologies has been essentially associated with the work proposals resolution and teacher's oral exposition, not registering the implementation of research-based learning and flipped classroom, whose potential suggests promoting the development of these skills.

Thus, the analysis of the results allows us to point out that, despite a significant number of lessons where strategies mediated by technologies had been implemented, it was not very evident that these strategies contribute in most lessons, for the development of the 21st century skills, such as critical thinking, creativity, communication and collaboration (Schrum & Levin, 2009). This situation may be due, in part, to the fact that these data correspond to the year of implementation of the pilot project, in which teachers and students are still appropriating technologies. Maybe, with the continuity of the project, more learning experiences might be promoted, in which the technologies can be used to further develop the 21st century skills.

Despite the recognition of the potential of strategies using technologies, there were identified some barriers to its implementation, in particular the exams (in the case of Mathematics), the extension of curriculum, learning goals' requirement and workload of teachers. Moreover, in the opinion of interviewed teacher, there are other factors that can lead to infrequent implementation of strategies mediated by technologies, such as the fear that the strategies do not have the expected results and the fear of no controlling students, as well as the fact that technologies can make the lessons more hectic and noisy. This last aspect, to be verified, meets PISA 2012, namely that the disciplinary climate is considered significantly worse when students report increased use of computers.

The developed investigation suggests that the integration of technologies must be associated with appropriate teaching strategies, innovative if possible, as well as the motivating and challenging tasks, avoiding an "aseptic and brainless use" of technologies in the classroom, "without any pedagogical-didactic contextualization" (Ruivo & Mesquita, 2013, p. 12).

Recommendations

In terms of future work, it is suggested the development of similar research in other subjects and in other levels of schooling. It would also be interesting to verify that if there is a more frequent implementation of innovative teaching strategies advocated in the EduLab model, when surpassed the phase of appropriation of technologies (pilot year).

It would also be interesting to implement the EduLab model with other schools and take the project off the Portuguese context, testing it in other countries.

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References

Balanskat, A., Blamire, R., & Kefala, S. (2006). *The ICT Impact Report. A review of studies of ICT impact on schools in Europe*. Retrieved from http://colccti.colfinder.org/sites/default/files/ict_impact_report_0.pdf

Bergmann, J., Overmyer, J., & Wilie, B. (2011). The Flipped Class: Myths vs. Reality. *The Daily Riff*. Retrieved from http://www.thedailyriff.com/articles/the-flipped-class-conversation-689.php

Bergmann, J., & Sams, A. (2012). How the flipped classroom is radically transforming learning. *The Daily Riff*. Retrieved from http://www.thedailyriff.com/articles/how-the-flipped-classroom-is-radically-transforming-learning-536.php

Bivar, A., Grosso, C., Oliveira, F., & Timóteo, M. C. (2013). Programa e Metas Curriculares de Matemática-Ensino Básico. Lisboa: Ministério de Educação e Ciência.

Bogdan, R., & Biklen, S. (1994). *Investigação qualitativa em educação: Uma introdução à teoria e aos métodos.* Porto: Porto Editora.

British Educational Communications and Technology Agency (2009). *Our work, its impact*. Retrieved from http://dera.ioe.ac.uk/10574/2/A9RCFE4_Redacted.pdf

Cachapuz, A., Praia, J., & Jorge, M. (2002). *Ciência, Educação em Ciência e Ensino das Ciências*. Lisboa: Ministério da Educação.

Carlos, V., Pombo, L., & Loureiro, M. J. (2014). Desenvolvimento profissional docente e comunidades online. Conceção de uma Oficina de Formação no EduLab do AEGN (projeto AGIRE). In G. L. Miranda, M. E. Monteiro, & P. Brás (Orgs). *Aprendizagem Online*, Atas do III Congresso Internacional das TIC na Educação (ticEduca2014), (pp.734-741). Retrieved from http://ticeduca2014.ie.ul.pt DOI: 10.13140/2.1.1633.7601

Carmo, H., & Ferreira, M. M. (2008). *Metodologia da investigação: guia para auto-aprendizagem*. Lisboa: Universidade Aberta.

Casa Nova, D. G. (2014). *Aprendizagem potenciada pela tecnologia no ensino superior* (Doctoral Dissertation, University of Aveiro, Portugal). Retrieved from http://ria.ua.pt/handle/10773/12480

Costa, F. A., Rodriguez, C., Cruz, E., & Fradão, S. (2012). *Repensar as TIC na educação – o professor como agente transformador*. Carnaxide: Santillana.

Coutinho, C. P. (2013). *Metodologia de investigação em Ciências Sociais e Humanas: teoria e prática.* Coimbra: Edições Almedina.

Despacho 232/ME/96 de 29 de outubro. Diário da República II Série nº 251/96.

Despacho 16793/2005 de 3 de agosto. Diário da República II Série nº 148/2005.

Dixon, B., & Tierney, S. (2012). *Bring Your Own Device To School*. Microsoft in the Classroom. Retrieved from file:///C:/Users/User/Downloads/Bring_your_own_device_to_school_briefing_paper_K-12.pdf

Documentation from AGIRE project.

European Comission (2013). *Opening Up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources.* Retrieved from http://ec.europa.eu/education/news/doc/openingcom_en.pdf

European Schoolnet (2015). *Designing the future classroom: BYOD Bring Your Own Device.* Retrieved from http://fcl.eun.org/documents/10180/624810/BYOD+report_Oct2015_final.pdf

E-Xample. Retrieved from http://www.e-xample.com/

Jonassen, D. (2007). *Computadores, Ferramentas Cognitivas***.** Porto: Porto Editora.

Lucas, S., & Vasconcelos, C. (2005). Perspectivas de ensino no âmbito das práticas lectivas: Um estudo com professores do 7º ano de escolaridade. *Revista Electrónica de Enseñanza de las Ciencias, 4*(3). Retrieved from http://reec.uvigo.es/volumenes/volumen4/ART4_Vol4_N3.pdf

Maier, P., & Warren, A. (2002). *Integr@ting Technology in Learning and Teaching: a pratical guide for educators.* London: Kogan Page.

Ministério da Educação (n.d.). *Organização Curricular e Programas, Ensino Básico 2º ciclo, Ciências Naturais. Volume I.* Lisboa: Ministério da Educação.

Organization for Economic Co-operation and Development (2014). *PISA 2012 Results on Focus: what 15 years olds know ant what they can do with what they know*. Retrieved from http://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf

Pombo, L., Carlos, V., & Loureiro, M. J. (2015). Edulabs for the integration of technologies in Basic Education – monitoring the AGIRE project. *International Journal of Research in Education and Science* – IJRES, 2 (1), 16-29. Retrieved from http://www.ijres.net/article/view/5000121574

Pombo, L., Loureiro, M. J., & Moreira, A. (2010). Assessing collaborative work in a Higher Education blended learning context: strategies and students' perceptions. *Educational Media International*, 47(3), 217-229. Retrieved from http://www.tandfonline.com/doi/pdf/10.1080/09523987.2010.518814

Pombo, L., & Talaia, M. (2012). Evaluation of Innovative Teaching and Learning Strategies in Science Education - Collaborative Work and Peer Assessment. *Problems of Education in the 21st Century*. 43, 86-94. Retrieved from https://www.dropbox.com/s/3xzlq4iu4hael7m/Pombo%26Talaia_PEC_2012.pdf?dl=0

Ponte, J. P. (1994). *O Projecto MINERVA - Introduzindo as NTI na Educação em Portugal*. Retrieved from http://www.educ.fc.ul.pt/docentes/jponte/artigos-por-temas.htm

Prensky, M. (2005). Shaping Tech for the Classroom: 21st-century schools need 21st-century technology. *Edutopia*. Retrieved from http://www.edutopia.org/adopt-and-adapt

Rego, B., Gomes, C., & Andrade, M. (2000). O Centro de Competência Nónio – Século XXI da Escola Superior de Educação de Viseu: dois Anos de Actividade. Revista Millenium, 17. Retrieved from http://www.ipv.pt/millenium/17_esf8.htm

Resolução do Conselho de Ministros n.º 137/2007 de 18 de setembro. Diário da República I Série nº 180/2007.

Ruivo, J., & Mesquita, H. (2013). A escola na sociedade da informação e do conhecimento. In J. Ruivo & J. Carrega (Coord.), *A escola e as TIC na sociedade do conhecimento* (pp. 11-28). Castelo Branco: RVJ Editores.

Seabra, C. M. C. (2013). *As redes sociais e a aprendizagem da matemática baseada na resolução de problemas – um estudo de caso com alunos do ensino superior* (Master's thesis, University of Minho). Retrieved from file:///C:/Users/User/Downloads/Cristina%20Marcela%20Cordeiro%20de%20Seabra.pdf

Schrum, L., & Levin, B. B. (2009). *Leading 21st Century Schools: Harnessing Technology for Engagement and Achievement*. California: Corwin.

Sousa, A. B. (2009). *Investigação em Educação*. Lisboa: Livros Horizonte.

Thomas, L. G., & Knezek, D. G. (2008). Information, Communications, and Technological Standards for Students, Teachers, and School Leaders. In J. Voogt, & G. Knezek (Eds.), *International Handbook of*

Information Technology in Primary and Secondary Education (Vol. 2, pp. 333–348). Retrieved from https://www.researchgate.net/profile/Margaret_Cox/publication/226572626_Researching_IT_in_Education/links/00b49530c88004f9db000000.pdf#page=365

Tucker, B. (2012). The flipped classroom. *Education Next*, *12*(1), 82-83. Retrieved from http://educationnext.org/files/ednext_20121_BTucker.pdf

Verdú, E., & Lorenzo, R. M. (2010). Effective strategies for learning: collaboration and competition. In E. Verdú, R. M. Lorenzo, M. A. Revilla & L. M. Regueras (Eds.), *A new learning paradigm: competition supported by technology* (pp. 11-40). Barcelona: sello Editorial.

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