Using the Methodology Problem-Based Learning to Teaching Programming to Freshman Students

João Paulo Aires, Simone Bello Kaminski Aires, Maria João Varanda Pereira*, and Luis Manuel Alves

***Abstract*—This work registers the initial results of a teaching strategy implemented with students entering the Algorithms discipline with a higher degree in Computing. This discipline offered to first-year students records cases of dropout and evasion. Thus, it is necessary to implement teaching strategies to provide engagement, interest, and motivation with the subjects worked on. The main objective is apply an active methodology problem-based learning in programming teaching. In this work participated 177 students in the years 2019-2 (47), 2020-1/2020-2 (83), and 2021-2 (47), enrolled in the first period of the course. The methodology adopted for the development of this study consisted of: use of questionnaires to measure prior knowledge about computing concepts; group discussion of the answers recorded in the questionnaire; development of an APP for smartphone; use of the PBL (Problem-based learning) methodology as a learning strategy. It is an activity related to the active teaching and learning methodology of problem-based learning that is being developed on the first day of class in groups of up to five students. The strategy consisted of two actions: 1) answering a questionnaire associating everyday computing elements; and 2) even though the programming concepts were not presented, the groups were challenged to develop a smartphone application. Each group received a questionnaire containing 19 questions divided into four blocks. What can be seen from the completion of this work was the enthusiasm, motivation, and engagement of the students, who, even though they were newcomers, organized themselves into groups and researched the necessary strategies to complete the challenge. When measuring the knowledge obtained through the application of a questionnaire relating to the content (with the participation of 62% of students), it was found that 81% of the participants obtained the necessary grade for approval of that content. Following the strategy of an active methodology of learning and teaching that favors the protagonism and autonomy of the student, we concluded that strategy was benefic for to the students, and the teacher acted as a guide in the teaching process, directing what should be researched to find the solution and serving as a tutor in the resolution of the problem presented. Preliminarily, part of this study was presented at the 2nd International Computer Programming Education Conference.**

***Index Terms*—Teaching programming, active methodologies, learning innovation, problem-based learning**

I. Introduction

Currently, through differentiated teaching methodologies, the educational environment has made progress in students' success [1]. Additionally, Aires and Pilatti highlight the essential elements, from basic education to postgraduate studies, to make this progress possible: 1) people who are enthusiastic about transforming educational processes; 2) school/university management combined with the interests of the community [1]. Several studies point out that the lack of motivation of students, which causes them to drop out or fail in undergraduate courses, is associated with factors inside and outside of the classroom [2, 3]. Among them, the following stand out: the teacher's teaching and learning methodology; students' immaturity when entering higher education; and the student's prior knowledge, which can favor a significant learning outcome [4].

Specifically in computing teaching the authors of [5] report that students usually have learning difficulties "as they need to develop computational skills and thinking" (p. 1). Garcia and Oliveira *et al.* [6] point out that Computer Science disciplines are characterized by having high failure rates, "as they require logical reasoning and mathematical knowledge".

Additionally highlights that the area has been experiencing constant challenges (and, consequently, problems) [7]. In this scenario, there are teachers investing a lot of time for the content and little time for practical and stimulating activities, generating students who are unmotivated and frustrated with the discipline. This makes "the classroom much more of an environment to be avoided than desired" (p. 233).

So, for learning to occur effectively, it is essential that the discipline, whenever possible, implement differentiated teaching methods in order to make the student a protagonist of learning and promote the absorption of the content in an appropriate way [8]. In this way, with the objective of promoting the engagement and motivation of students and consequently expanding the use of the content, it was proposed applying a teaching and learning methodology based on problems. This methodology was used on the first day of class in the Algorithms discipline in an undergraduate course in Computing. It is important to note that, to carry out the activity, no prior knowledge about programming was necessary.

Thus, one of the purposes of the study was the application of a differentiated teaching methodology, to make students reflect on basic/elementary concepts of computing, such as operating systems, memory, processing, storage, data types, input, and output, among others. Such knowledge is present in everyday life, especially on smartphones. It is noteworthy that, despite being an experiment carried out in the first week of the discipline, the activity promoted motivation and integration among the students in the class from the first day of class, through the creation of study groups to promote discussion about the problem presented by the teacher. The problem proposed in the work activity allowed it to be related

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to the real world by comparing the characteristics (and functionalities) of a smartphone with those presented on a computer.

II. The Use of Active Methodologies in the Teaching and Learning Process

Active teaching and learning methodologies can be understood as any teaching strategy aimed at promoting the active participation of students in the teaching process [6, 7], [9] and in the continuous construction of their learning in a flexible way, to promote meaningful learning [10, 11]. In this scenario, Fonseca and Gomez [12] point out the need to carry out educational changes based on the competencies that students must develop, due to the pedagogical failure of the results-based approach.

Such active methodologies favor contact with new experiences for students, whether in the interventions promoted by the teacher (student-teacher dialogue) or in the discussions promoted with colleagues [9]. Through them, the student, autonomously, seeks the elements necessary to consolidate knowledge, contributing to his personal and professional life, as, in addition to strengthening his role, he improves his ability to face daily challenges.

Additionally, Mitre *et al.* [13] argue that active methodologies should always use problematization, with the objective of challenging and motivating the student, since the problem allows the class to analyze the objectives, reflect on hypotheses, relate possible solutions and test/record the findings obtained. Learning through this strategy will allow maximum involvement of students, acting actively and protagonist in the process of professional training.

Finally, in the understanding of Moran [14] and complemented by Moya [9], active methodologies are based on the student as the center of learning, being associated with individual or group activities, participating in learning processes in a way collaborative and through the exchange of experiences. The teacher organizes the teaching process, however, it is up to the student to seek new elements to favor their learning and, with that, achieve the objectives proposed in the discipline [9].

According to Ribeiro and Passos, Barseghian, Rodríguez and Díaz *et al.* [5, 15, 16] there are several strategies to be used in the classroom, especially: dialogued expository class; case study; team-based learning (TBL); problem-based learning (PBL); project-based learning (PBL); peer instruction; Flipped classroom; gamification.

Studies carried out by [5, 7, 13, 15, 17], point out that the use of active methodologies enables new experiences for the class, regardless of the content being worked on. The student, on their own and knowing the real need for such action, seeks the new, and this initiative greatly contributes to sharpening their critical sense and their capacity for reflection in their professional life, working on their autonomy and ability to face the challenges.

When it comes to teaching computing, several studies relate positive results in the application of differentiated methodologies inside classroom [5, 7, 18].

Ribeiro and Passos [5] analyzed 35 studies through a systematic literature review. They found that six methodologies stand out when it comes to teaching computing (from the most applied to the least applied): gamification, problem-based learning, project-based learning, peer-instruction, flipped-classroom, and team-based learning.

The research described in [7] analysis is made of the application of PBL in computing classes. They found that, in the last 20 years, there has been an expansion of research in computing, which reports the application of active methodologies, in particular, PBL, bringing real problems to be worked with students.

Garcia and Oliveira *et al.* [18] applied a teaching strategy in the teaching of Algorithms, which involved several active methodologies (such as gamification, TBL, PBL, and virtual learning environments, among others) and concluded that there were advances in student learning when compared to traditional teaching methods.

Thus, as it is pointed out in the presented studies, it is relevant to use innovative teaching strategies that are able to motivate, encourage, and provide students with autonomy and protagonism.

However, if, on the one hand, it is up to the student to seek additional concepts to solve a given problem, on the other hand, the application of these strategies depends, essentially, on the teacher's effort to organize the discipline aimed at the students' protagonism.

III. Methodology

This work addresses the application of problem-based learning in programming teaching through research with an exploratory approach, using a predominantly qualitative analysis of the problem. In relation to technical procedures, a survey was carried out, and the composition of the documentary corpus was based on questionnaires collected from students enrolled in the discipline.

The teaching and learning strategy was applied on the first day of class to a group of students in the Algorithms discipline from the first period of the Bachelor's Degree in Computer Science. At this point, general concepts about memory, operating system and processing tasks are discussed considering the student's prior knowledge [1]. The central idea was, through the presentation of the problem "What is the similarity between a computer and a smartphone?" to propose the discussion (in groups of up to four students) of the relationship between the devices.

The methodology of this work was structured according to the following procedures:

1) Initially, through a questionnaire containing 19 questions, the students worked in groups and, through brainstorming, reflected on the elements that involve the daily use of a smartphone/computer. The questionnaire was divided into four parts and explored previous knowledge about the concepts presented in the questions.
2) After the group answered the questions, the teacher promoted a discussion about the content of the questionnaire, seeking the consensus of the class for the main questions, relating the similarities between a computer and a smartphone, and highlighting the initial

concepts of programming.

3) After the discussion, the challenge was to develop a calculator application that could be installed on the groups' smartphones. The development was carried out through programming in blocks without having explored concepts of structured programming (such as variables, data types, input and output, and decisions, among others).

The objective of the proposal was to make students reflect on the elements so that the application could be developed (and subsequently installed). During the course development, the content worked was related to the parts of the application developed to allow the treated concept (variables, for example) to be assimilated by the student.

Next, the methodological procedures are presented in more detail.

The study was applied for three semesters (2019-2, 2020-1/2020-2, and 2021-2), in the first classes of the Algorithms discipline of the Bachelor of Computer Science Course, in which there were only freshmen students enrolled. The number of participants is shown in Table I, all enrolled in the first period of the mentioned discipline.

TABLE I: STUDENTS PARTICIPATING IN PBL

Year-Semester	Number of students
2019-2	47
2020-1 / 2020-2	83
2021-2	47

Note: at the institution where the study was carried out, due to the COVID-19 pandemic, the 2020-1 and 2020-2 semesters were implemented at the same time.

As mentioned, the teaching strategies used in the initial classes of the Algorithms discipline were based on the active Problem-Based Learning (PBL) methodology, which aims to place students in front of a real problem, to be solved in a group. It was chosen to use PBL, since, as these are students from the first period of the course (and their first contact with the universe of programming), this methodology allows for different solutions to the same problem to be presented and discussed.

To provide student interest with the content worked on in the discipline, on the first day of class, the teacher presents a theme that everyone is familiar with on a daily basis: the use of smartphones. Through a set of questions, students are encouraged to discuss the main features that mobile devices have, such as capturing photos, making video calls, email editing, accessing social networks, storage capacity, Operating systems, RAM memory, among others. Then, students must organize themselves into groups to, through a questionnaire, reflect on the features/internal characteristics of the devices.

In the questionnaire, students are invited to carry out an immersion/reflection on their smartphone. Many questions were asked based on the essential settings that are evaluated when someone is looking for a cell phone to buy. According to Felder and Brent [19], the tasks to be distributed to students should be organized so that they can be performed in a short period of time so as not to discourage the students from participating.

Thus, the questionnaire (which contains 19 questions in total) was divided into four blocks/parts. The first block can be seen in Fig. 1. The 19 questions can be accessed at this link https://1drv.ms/b/s!AqqpbKeTHqetkK4f7IaYsIBbdDi3ww?e=imoRKg.

Ministério da Educação
Universidade Tecnológica Federal do Paraná
Algoritmos - Câmpus Ponta Grossa

UTFPR

Problema: Desenvolver um APP para celular Android

PARTE 1

Conteúdos: variáveis, constantes, atribuição, entrada e saída.

Grupo: ____________________

1. Porque um iPhone 7 128GB é mais caro que um iPhone 8 64GB?

iPhone 8 64GB Cinza Espacial Tela 4.7" IOS 4G Câmera 12MP - Apple
(99)
4 ofertas a partir de
R$ 2.499,00 prime
12x de R$ 208,25 sem juros

iPhone 7 128GB Preto Matte Desbloqueado IOS 10 Wi-fi + 4G...
(21)
R$ 2.699,00 prime
12x de R$ 224,91 sem juros

2. Porque preciso de um celular com uma grande capacidade de armazenamento?
3. Você saberia verificar quanto de espaço ocupa cada APP instalado em seu celular?
4. Você já verificou quanto de espaço ocupa uma foto (imagem)? Se sim, qual o tamanho e sua resolução (qualidade)?
5. Você conhece a menor medida de armazenamento em dispositivos digitais? Se sim, qual?
6. Uma imagem com tamanho 1.6 MB, representa quanto de espaço quando convertido na menor medida de armazenamento em um dispositivo digital?

Fig. 1. A quiz about smartphone features.

It can be seen in Fig. 1 that the activity was organized in such a way that the questions were linked to computation (even though it sounds basic to some students).

Such questions sought to establish a correlation between the real world and the initial contents of the programming discipline. After applying the questionnaire, a challenge is proposed to the students: to design a calculator for a smartphone.

After investigating how the smartphone works, students are encouraged to develop their own APP so that they can test and "display" the app working on their smartphones.

As this is the initial programming class, no concepts related to the structure of a program have been addressed (for example, variables, data types, and decision structures, among others). Thus, students were instructed to create the APP for smartphones, using the MIT APP Inventor tool [20], in which the organization of functionalities is based on a block structure. The platform (Fig. 2) allows the development of the interface with a series of visual components and a specific area for programming in blocks (Fig. 3).

Fig. 2. Home screen of APP inventor – interface development.

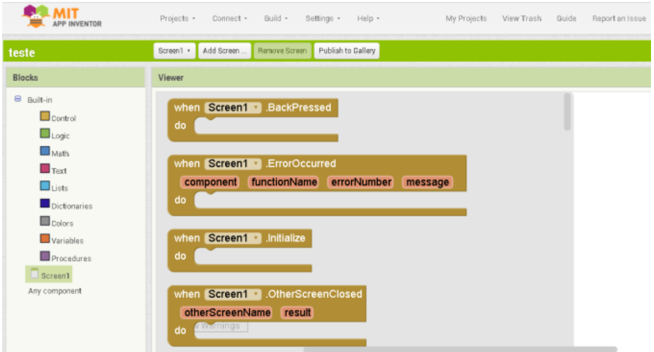


Fig. 3. Home screen of APP inventor – block programming.

MIT APP Inventor is an open-source platform for mobile APP development with the Android system. It was created by Google in 2010 and is currently maintained by the Massachusetts Institute of Technology (MIT). The platform uses block programming language (similar to what happens in the Scratch tool) and development is done directly in the browser. At the end of application development, the tool makes available the APP installer download (via a .apk file) [20].

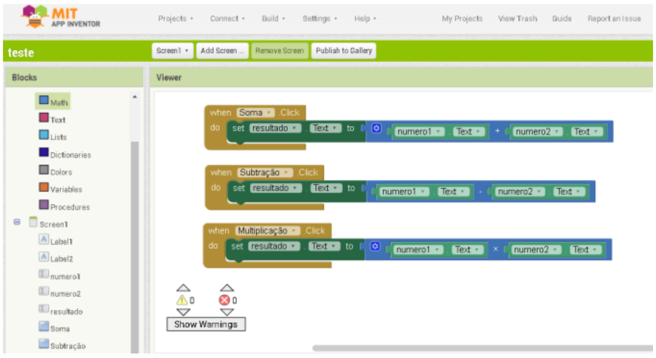


Fig. 4. Structure of a code in MIT APP inventor.

As you can see in Fig. 4, the code is organized through programming blocks, in which each structure is related to the functionality that will be performed. For example, once you've been asked to create a calculator, you have a separate block to perform each of the four basic operations (addition, subtraction, multiplication, and division).

After the initial reflections and discussions with the class, the teaching strategy followed the following flow:

1) The internal smartphone features questionnaire is being discussed;
2) Challenge students to create (in groups or individually) a smartphone calculator;
3) Without a refined explanation of programming concepts, the class faced the challenge of developing an application for smartphones;
4) The calculator should be developed using the MIT APP Inventor tool;
5) The APP must be installed and tested on the smartphone;
6) Presentation of the developed APPs (in the week following the initial discussion);
7) At the end of the proposed activities, and with the course having advanced the content, a questionnaire is applied with questions related to the studied computing concepts, in order to verify how students, associate the worked content with the features of the developed APP. With the answers obtained, it was possible to observe the learning obtained by the students.

In Fig. 5 you can see steps 1 and 2 used in the proposed methodology. Initially (step 1) the groups of students answer the questionnaire that relates the features contained in their smartphones to the features of a computer. After discussing the questions proposed in the questionnaires, students are challenged to develop a smartphone calculator (step 2).

Fig. 5. PBL – APP smartphone.

IV. Results and Discussion

As pointed out in studies on active teaching and learning methodologies, which emphasize that groups must be composed of a maximum of five students, the proposed activity defines this strategy as a rule in the organization of teams. As students are new to the computing course, the process was conducted in order to direct the topics to be worked on, as well as the reasoning sequence (steps) to obtain the desired learning results. It is up to the teacher to assume the role of advisor in this study process.

Following the work developed by Felder and Brent [19] and to avoid the dispersion of the class, the time required to carry out an activity in the classroom cannot exceed 20 minutes. Thus, the questionnaire containing questions for group reflection on the internal characteristics of smartphones and their relationship with computers was organized into four blocks containing four to six questions each. In the teaching strategy used, each block of questions is presented to the groups and, subsequently, there is a discussion with the whole class.

The applied dynamics took place in two moments for each block of questions. Initially, the groups met, discussed, and researched each question presented. After ten minutes of group discussion, the debate with the whole class is expanded, in which each group expresses its response. During the discussions with everyone, the cooperation between the groups was observed, and often, one group complements the answer of the previous one. It was up to the teacher to intermediate/organize the responses presented and instigate cooperation and complementation between the groups. It should be noted that, whenever necessary, the teacher must explain the content that is not understood or complement some important information that has not been observed by any group.

Figs. 6 and 7 show the responses recorded by the groups, taking into account the 19 questions provided in the activity for the class (answers from other groups can be seen in [21]. As indicated in the methodology section, the questionnaire was sized so as not to generate low student involvement.

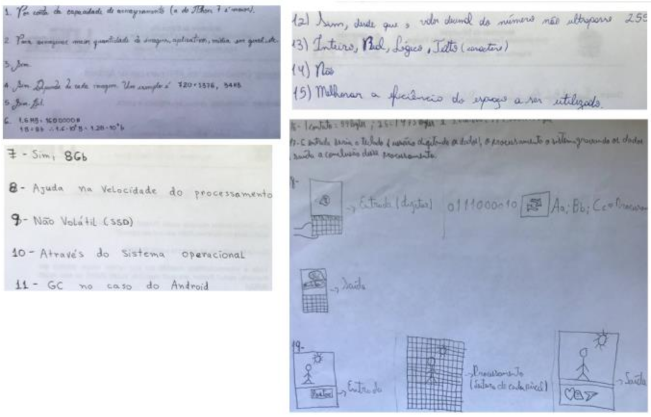


Fig. 6. Answer blocks from different groups.

7. Does your phone have volatile memory (RAM)? If yes, can you say the amount of RAM memory your phone has?

Answer = Yes, 1GB Samsung core plus
Answer = Yes, 4GB Xiaomi Mi 8 Lite
Answer = Yes, 4GB iPhone 12
Answer = Yes, 4GB Xiaomi Redmi 9

8. What is the importance of volatile memory (RAM)?

Answer = The RAM memory is necessary for the execution of all the processes in the computer, inside it are stored the programs and the OS (Operating System) during the use of the PC. When there is no memory available, the computer starts using the hard disk as virtual memory for the execution.

9. Why is an iPhone 7 (128 GB) more expensive than an iPhone 8 (64 GB)?

Answer = The 128 GB iPhone 7 has a slightly higher price compared to the 64 GB iPhone 8 due to the larger amount of internal memory. Despite the iPhone 8 being a little more evolved in some aspects, such as the camera, the finish and the processing, the internal memory still stands out, due to the individual's need to use more and more storage and also because the devices are identical.

10.Consider/Imagine an APP that stores basic information about your contacts: name, age, height, telephone and e-mail. For name and e-mail, you can enter a maximum of 20 letters (characters) for each of the information and the 14-digit telephone number. What is the space occupied in memory to store all this information/data for 1 (one) contact? How much space for 25 contacts? How much space for 3,000,000 contacts?

Answer = Taking into account that each letter or number weighs 1 byte, and in total information would have 59 bytes, 1 contact has 59 bytes, already 25, 1475 bytes, already 3,000,000, 177,000,000 bytes, in MB, 177 Megabytes .
20 name. 20 email. 2age. 3 height. 14 phone. Total 59 bytes.

Fig. 7. Answer blocks from different groups.

What can be seen is that the answers follow the particularities of the smartphones of each student/group. It is also observed that some groups registered different information for the same question due to the configuration of the group members' devices. This was very interesting, as it demonstrates that they perceived the existence of different configurations, favoring the discussion of important aspects and also carrying out a deeper analysis at the time of a future acquisition.

After this phase, the challenge of developing a calculator for smartphones was launched, which should be installed on the group's devices. When this problem was presented to the class, it was found that some students with greater knowledge questioned whether they could develop the APP using prior programming knowledge, for possible validations, for example. On the other hand, those students who do not have experience with the content were apprehensive, scared, and worried about the strategy that should be used to solve the task.

At this point, it was up to the teacher to present some possibilities to solve the problem. Among them, the APP inventor programming environment is displayed (available at [20]), in which it is possible to perform the task using only block programming (similar to what happens in Scratch). The teacher's intervention, directing the environment to be used by the students, does not solve the problem. This action works as a tutoring/orientation, indicating to students what should be researched, so that, in an autonomous way, they can reflect on and develop the proposed problem.

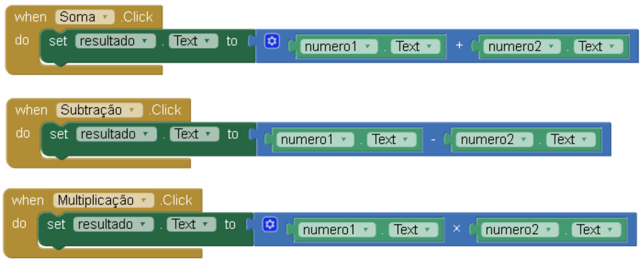
Fig. 8 illustrates some of the screens of applications created by students (and installed on smartphones to demonstrate how they work), proving that the groups found a solution to the proposed challenge. Note the diversity of ideas that emerged, each with a different interface and without the need to initially use lines of code in a programming language.

Fig. 8. Some calculator screens.

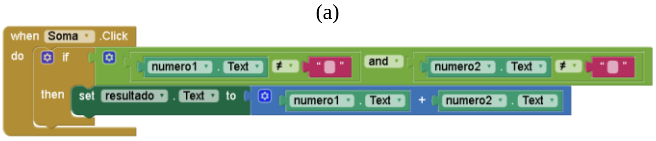
Additionally, it can be seen that Fig. 8 registers the essence of the PBL methodology, in which it points out that a problem has numerous solutions. Each group structured the interface using different strategies.

Additionally, is verified in Fig. 9 (a) and (b) the code blocks used in distinct groups. It is important to note that the problem presented did not charge or require the entry validation rule for numbers, for example. This situation (entry validation) was pointed out when presenting the programming content and, by reviewing the developed applications and entering the data, the students were able to understand the need to restrict a certain number to be entered (as in the case of a division by zero, for example).

Anyway, even though it was not explicitly stated, some groups had the perception of validating the entries (as in the case of requiring only numbers and not allowing blank information, for example), as can be seen in the validation blocks identified in Fig. 9 (b).



(a)



(b)

Fig. 9. (a) Code blocks used by one of the groups; (b) Code blocks used by another of the groups.

As can be seen in Fig. 9(a), the blocks used to build the calculator (and perform the calculations) were organized without worrying about validating the numbers entered.

Since such verification was not required (the problem was to develop and install the APP on the smartphone), this cannot be understood as a student error, since the teaching methodology itself indicates that every solution to the problem, as long as it solves it, is understood to be adequate. For example, if in a calculator perform takes place the calculation 4 – 8 (with or without implemented validation), the result will be −4. The fact that there is validation for this particular calculation would make no difference.

Fig. 10 presents the screen of an APP, developed by one of the groups, and the code corresponding to the functionalities required in the proposed challenge. As you can see, the programming is organized using the blocks predefined in the APP Inventor platform, making the structuring of the code a task performed in an intuitive way (based on components and actions registered on the screen of the developed application).

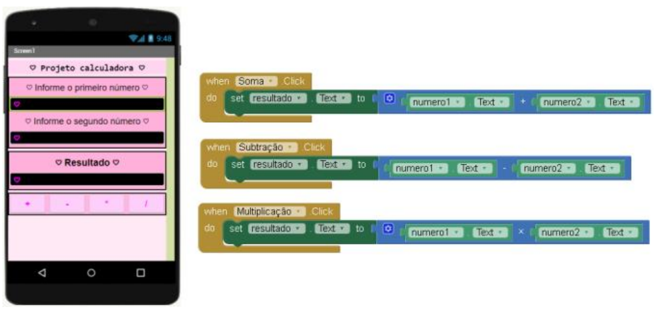


Fig. 10. APP developed by students.

To consolidate the acquired knowledge and measure what each student was able to understand about the contents covered in the strategy implemented in PBL, a questionnaire was applied using the Moodle platform, containing 13 questions (three descriptive questions and ten multiple-choice questions) related to the topics discussed and researched during the performance of the programmed activities. The purpose of applying the questionnaire was to verify how each student would make the relationship between the problem studied and the concepts included in the proposed challenge.

Some of the applied questions are listed below:

1) Which questions or subjects, based on the topics discussed in the cell phone activity, provided you with new knowledge?
2) In general terms, would you know how to explain the computer system that sends an e-mail? What would be the input(s), processing(s), and output(s)?
3) Who manages the memory space on the cell phone?
4) When we install an APP on our cell phone, is it stored in non-volatile memory (SSD)?
5) Whenever I open an APP (e.g. Instagram) is it loaded into the SSD memory?

With the students' answers, Table II presents the averages obtained by the classes, as well as the highest and lowest grades. As can be seen, considering the average obtained in the questionnaire in each semester of application, it appears that the students were able to relate the computing concepts through the proposed challenge. It should be noted that in the 2019-2 semester, as this was the first time the proposal was implemented, the questionnaire was not applied. This was only carried out in the following semesters, at which time refinements were made to the proposal, such as adjustments to the 19 questions in the initial questionnaire, organization of virtual rooms for group discussion (with the collaboration of the professor, to advise on any eventual doubts).

TABLE II: AVERAGE OBTAINED IN THE STRATEGY EVALUATION QUESTIONNAIRE

Year-Semester	Lowest Grade	Highest Grade	Average obtained
2019-2	*	*	*
2020-1/2020-2	2.8	10	7.7
2021-2	4.5	10	7.4

The 2020-1/2020-2 class was composed of 87 students and, of these, 67 answered the applied questionnaire, recording an average grade of 7.7. Of the total responses, 56 students (84% of respondents) scored above the university average (6.0 points) and 11 students (16%) scored lower. Of these 11 students, six of them scored between 5.1 and 5.8 (close to the passing rate). The 2021-2 class was composed of 50 students and 43 answered the questionnaire, obtaining an average of 7.4. Of the responses recorded, 33 students (78% of respondents) scored above the university average and 10 students (22%) scored lower. In view of the average presented in the applied questionnaire, it is understood that the teaching strategy used favored the learning of the class.

When analyzing the results obtained, it is possible to affirm that the strategy used in the classroom had positive results, since the students were able to relate the concepts covered in the activity with the contents necessary for the beginning of the discipline, since most respondents in both questionnaire application opportunities (81%) scored above the average required for approval.

When observing the activities carried out by the groups, it was found that the experience proved to be valid and interesting, due to the involvement of students, their integration in the groups, the motivation in the discussions promoted with group colleagues, and those promoted by the teacher, and the developed applications.

Additionally, it is highlighted that the anxiety and concern presented by freshman students at the beginning of the course were overcome through their engagement in carrying out the work. What at the beginning was something that worried them, as they thought they were not capable of doing it, generated additional motivation and disputes in the group, to see who could finish first. The exchange of the APP developed among the students was observed, as well as others implemented by them on the platform, which was possible with the experience and knowledge acquired in this activity.

V. Conclusion

The use of a differentiated teaching and learning methodology, provided moments of relaxation, motivation, class involvement, and integration among colleagues who had just met. The initial impact and anxiety gave way to the motivation to learn the content presented, with one detail: some students who participated in the experience had not had contact with programming before entering the course.

The immersion of the groups in the use of APP Inventor, to develop the solution that worked on a smartphone, allowed them to explore the creativity and freedom to register the group's solution. This ensured that they overcame the challenge and delivered a product that solved the problem initially presented. As pointed out by the students in the evaluation of the strategy, it appears that the teaching proposal was well received by the class, which allows for progress in the application of other innovative teaching methodologies so that the contents are better used by students and provide them autonomy, protagonism, and meaningful learning.

In the evaluation of acquired knowledge, carried out in 2020-1/2020-2 and 2021-2 using a questionnaire containing questions related to the content, it was found that most students had a satisfactory performance (81% obtained a grade above the passing grade at the university). Thus, it is understood that the teaching problem made available to students was well suited, promoting active involvement of each student in the activity and, therefore, greater absorption of the knowledge presented.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

João Paulo Aires and Simone Bello Kaminski Aires, structured and applied the teaching strategy, data analysis and article writing. Maria João Varanda Pereira and Luis Manuel Alves organized the bibliographic survey, translated the article into English and revised the writing. Finally, it is noteworthy that all authors read the final version and agreed with the publication of the manuscript.

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