Fostering Programming Logic Skills in High School Students Through Project-Based Learning: An Educational Experience

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ABSTRACT

In recent years, the burgeoning demand for skilled professionals in the technology sector has become increasingly evident. Capitalizing on this trend, a non-governmental organization in Rio de Janeiro recognized it as a unique opportunity to empower the city's youth. In collaboration with a public university, it was proposed a training program focused on programming logic with Python and an introduction to data analysis, specifically tailored for high school students. Thus, this work aims to present the experience of designing and implementing this course. With a clear emphasis on the unique characteristics of our target audience, we crafted a curriculum utilizing active teaching methodologies: Project-Based Learning and the Flipped Classroom approach. By the conclusion of the course, students not only demonstrated their ability to complete the proposed projects but also actively participated in an evaluation of their learning experience, answering a questionnaire and participating in interviews. The results of this evaluation were overwhelmingly positive, shedding light on the student's desire to pursue further studies in computer science.

CCS CONCEPTS

• **Social and professional topics** → Computing education.

KEYWORDS

Project-Based Learning, Flipped Classroom, Programming Logic, Python

1 INTRODUCTION

The number of job openings in the technology sector far exceeds the pool of qualified professionals available to fill them. In Brazil, as per estimates from the *Associação das Empresas de Tecnologia da Informação e Comunicação e de Tecnologias Digitais*, approximately 800,000 new positions are projected to be created within five years. However, the annual production of technology professionals hovers around 53,000, leading to a substantial deficit of 532,000 skilled individuals required to meet the industry's demands [9].

This challenge is not unique to Brazil; in the United States, for instance, Breaux and Moritz [4] highlight a 22% expected increase in software development positions. Paradoxically, there is a concurrent trend indicating a potential 25% reduction in the Information Technology workforce.

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Due to this context, one of the motivations for this study arises from the employability scenario in the technology market, coupled with what Wang, Vemula and Frye [11] emphasize in their article: early exposure to programming content, even in school, can generate a genuine and lasting interest in the field, contributing to the formation of more qualified professionals.

Furthermore, a non-governmental organization (NGO), from a city of Rio de Janeiro state, sees this scenario as an opportunity for the local community. The responsible team understands the social impact that the programming course can have on students. Emphasizing that programming skills are of utmost importance in showing high school students future options upon completing their education, such as pursuing higher education or entering the technology job market in a qualified manner.

The NGO team established a partnership with a federal university. Researchers from the university conceived a programming course to teach programming logic with Python and introduce data analysis. The target audience was individuals who were still in school, utilizing active teaching methodologies to generate greater interest and engagement among students.

The objective of this paper is to elucidate the process of conceiving, structuring, and implementing the course. The course design strategically incorporated Project-Based Learning (ProjBL) and Flipped classrooms as active teaching methodologies to captivate participants' engagement.

Consequently, the curriculum took the form of a fundamental Python course, infused with ProjBL elements. After a student selection process, the course spanned four months. Upon its conclusion, a comprehensive survey, questionnaires and interviews, were conducted to gauge students' perceptions of the course, with a particular focus on their experiences with the active teaching methodologies employed.

This paper is organized as follows: the next section shows fundamental concepts that this work is based on; the third section presents related research; the fourth section focuses on the design process of the course; the next one presents the dynamic of the course during the four months; sixth section shows the results and discussion of the questionnaire and interview; finally, the seventh section presents the conclusion.

2 THEORETICAL FRAMEWORK

This section is dedicated to elucidating key concepts essential for a comprehensive understanding of this study. First will be explicited the concept of Flipped Classroom, which was employed during the course. Following, the Project-Based Learning methodology used will be presented in detail.

2.1 Flipped Classroom

The flipped classroom is an instructional method where the content is delivered to students outside the classroom, while in-class time is reserved for the practical application of previously covered material [2]. This paradigm shift is designed to place the student at the forefront of the learning process, fostering greater autonomy and, consequently, heightened motivation [1].

Most studies revised in Akçayir and Akçayir [1] have consistently indicated that the adoption of this method has positively influenced student engagement and motivation in the classroom, both of which are pivotal factors in enhancing the learning process. Nevertheless, it is essential to acknowledge potential challenges that may arise during implementation: maintaining the quality of materials that are sent to students throughout the course; communication outside the classroom; and access of students to computers and materials needed.

Sobral [10] exposes that the use of this methodology is regarded as positive in teaching experiences for programming. The works revised reports that students prefer to utilize class time for practical application of theory, such as solving exercises through pair programming or project-based learning. As Akçayir and Akçayir [1], it's also pointed out that the quality of the materials provided to the students is crucial for the success of the experience and, also, emphasizes that lengthy videos can demotivate the students.

2.2 Project-Based Learning

Project-Based Learning (ProjBL) is a methodology aimed at fostering student engagement in the learning experience [3]. Within this framework, students are encouraged to proactively seek solutions to non-trivial challenges, involving themselves in activities such as seeking clarification, engaging in discussions, devising strategic plans, conducting experiments, crafting tangible artefacts, or gathering and scrutinizing data, among other dynamic learning endeavours.

Larmer, Ross and Mergendollar [7] provides a comprehensive description of the critical components necessary for a course to qualify as an application of ProjBL:

(1) Significant content
(2) 21st century skills
(3) In-depth inquiry
(4) Driving questions
(5) Need to know
(6) Voice and choice
(7) Revision and reflection
(8) Public Audience

Larmer, Ross and Mergendollar [7] also argues from various perspectives regarding the effectiveness of the methodology for elementary and high school students. In general, teachers have noted an increase in student motivation, along with the methodology facilitating the connection of classroom content to real-world issues. Researchers, while acknowledging the need for further research, also point out that ProjBL can enhance student engagement and motivation, improve long-term knowledge retention, and foster the development of 21st-century skills.

3 RELATED WORK

The following paragraphs present three different similar studies. They aim to teach programming languages using Project-Based Learning. However, some apply ProjBL with a different perspective. These studies were selected through ad-hoc research and their good results and evaluations on the use of ProjBL were a reinforcement for the course design.

In both Wang, Vemula and Frye [11] study and this work, the driving force lies in the escalating demand for tech-related job opportunities. Recognizing the imperative to cultivate students' interest early on, Vemula and Frye [11] emphasizes the significance of exposing young learners to computer science subjects, with a particular focus on fostering gender diversity. To this end, they conducted a Python course targeting high school girls, utilizing Project-Based Learning as the teaching methodology. The course, delivered in eight in-person sessions over two weeks, introduced fundamental programming concepts through practical, real-world projects. The evaluation of the experience included questionnaires and interviews, revealing promising results and reaffirming the girls' burgeoning interest in computer science.

The methodology in this study differs from [11] by posing a driving question rather than presenting closed projects, aiming to enhance students' problem-solving abilities and bolster their engagement with programming [7]. Ultimately, both studies converge in their commitment to inspiring students and ensuring that they are well-prepared to excel in the evolving landscape of technology opportunities.

In the study by Lira et al. [5], a pressing issue regarding STEM (Science, Technology, Engineering, and Mathematics) graduation rates is highlighted. They identify two major contributing factors: the absence of encouragement for pursuing STEM careers and the lack of early exposure to these fields during students' educational journeys. This challenge is further compounded by the burgeoning demand for IT professionals in the job market. In response to these concerns, the study describes a one-week camp designed to impart fundamental Python programming concepts to a group of 19 students.

The camp adopted a Project-Based Learning, emphasizing practical application alongside theoretical content. The central project, the creation of a "snake game," evolved incrementally throughout the course, introducing new functionalities in tandem with students' theoretical progress. The educational experience was evaluated through a comprehensive opinion questionnaire, completed by all participants. While the course successfully conveyed basic programming knowledge, some students encountered difficulties in code analysis and debugging. Interestingly, the camp did not lead to a discernible increase in students' motivation to pursue computing careers. This experience shares similarities with the proposed course in this project, particularly in its project-based learning approach, yet differs in the absence of a driving question and the use of a predefined project scope, aligning with the methodology outlined by Wang, Vemula and Frye [11].

In the study by Jagannathan and Komives [6], the spotlight is cast on the issue of gender underrepresentation in the technology sector, with a particular focus on the limited female presence. The study attributes this gender gap to educational practices in schools

that often steer boys toward careers in engineering and technology, while girls face discouragement. To address this imbalance, the researcher embarked on a multi-year journey, spanning from 2014 to 2019, during which they provided private lessons to a group of girls. The primary objective was to introduce them to programming and artificial intelligence (AI) in hopes of igniting their interest and creating pathways for future careers in technology.

The educational journey began in elementary school, with basic Python programming, and evolved to incorporate hardware-software interfaces by 2016. A pivotal aspect of this endeavour was the application of Project-Based Learning (ProjBL) in 2016, which involved tasking the girls with identifying real-world problems and devising wearable solutions. They would then present their innovative creations to family members and peers. As the girls progressed to high school between 2017 and 2019, the curriculum shifted its focus to artificial intelligence, featuring predefined projects. The research ultimately gauged success based on the girls' accomplishments throughout the years and their expressed intentions to pursue careers in engineering and computing. Despite the extended timeframe of this initiative, it aligns with the course proposed in this study, particularly in its utilization of ProjBL as a pedagogical approach, which encourages students to begin with open-ended questions and culminate their learning with presentations, fostering essential 21st-century skills such as effective communication and public speaking.

The previous studies exhibit both similarities and differences about the proposed research subject. While the application of Project-Based Learning (ProjBL) has been emphasized in all these works, distinctions emerge in terms of the duration of the course, the number of students involved, and the target audience. It's worth noting that some studies specifically targeted a female audience, whereas the current study encompasses a mixed-gender course. The following sections will focus on presenting the conception, implementation and evaluation of the proposed course.

4 COURSE DESIGN

Employing the ProjBL methodology enhances students' 21st-century skills, fosters their autonomy and actively involves them in tackling real-world challenges, as highlighted by Larmer, Ross and Mergendollar [7]. Given these advantages and the favorable outcomes observed in related studies, it becomes evident that the integration of active methodologies, as a broader educational approach, holds promise for the overall success of the course.

The following subsections will go into detail about the course planning and structure. Going deep on the usage of ProjBL elements, the syllabus, and the process of student experience evaluation.

4.1 ProjBL Structure

The eight essential elements proposed by Larmer, Ross and Mergendollar [7] were used to plan the course. The following topics show how these elements influenced the lecture.

(1) **Significant Content**
- As presented in the Introduction, the demand in the technology market is on the rise, far from being met by the current number of qualified professionals. In this scenario, the programming knowledge offered by the course proves to be highly relevant for those wishing to enter this field.

(2) **21st-century Skills**
- For the course, the focus was on the following 21st-century skills:
  - Critical thinking
  - Problem-solving
  - Communication
  - Collaboration
  - Public speaking
  - Time management
- Critical thinking and problem-solving were expressed during the final project resolution, Python code writing, and selected data analysis. Communication and collaboration were predominantly exercised when dealing with the group to reach a final result. To practice public speaking, participants were frequently required to present their code and exercise resolutions, in addition to the project presentation. Finally, time management was practised in conjunction with the flipped classroom dynamics, where students needed to organize themselves to review the content before synchronous meetings.

(3) **In-depth Inquiry**
- Having a project close to the participants' daily lives, some actions were taken to keep students engaged throughout the course: the separation of working groups from the first day of class and the organization of weekly synchronous meetings with the teacher so that they could clarify doubts and continue the project. With groups defined from the beginning, students could already discuss and decide on the theme and working method. The two weekly meetings lasted for an hour and a half, and after the course content was completed, time was given for students to focus entirely on the project until the delivery date.

(4) **Driving Question**
- To engage students with the course and the project, a question relevant to their daily lives was considered. The chosen motivating question was: "How to improve the city you live in?". Thus, the expectation was that by the end of the course, students would have a Python project with data analysis to answer this question.

(5) **Need to Know**
- The Python content was organized on the Moodle platform, allowing students to understand what they needed to know how to complete the project.

(6) **Voice and Choice**
- The project specification consists of the motivating question; thus, students had the space to decide which implementation and resolution path to follow. The only restrictions were that they should use the Python language and the Google Colab development environment to practice the course curriculum. If it was perceived that an intervention was needed in the project to keep it on the right track, comments would be made so that students could autonomously make a decision.

(7) **Review and Reflection**

- Students had the space of the synchronous meeting to provide feedback on the course, but a weekly form was also passed to collect the week's perception, aiming at the course's and learning experience's evolution.

(8) **Public Audience**
- To practice public speaking and fulfill this element of ProjBL, teachers from the university and NGO employees were invited to be part of the audience during project presentations.

4.2 Syllabus

The target audience of the course were high school students or recent graduates, therefore was not expected of the participants to have any programming experience. The only requirement was to have the interest and eagerness to learn to program. The course content was provided by the online platform Moodle[1] and it had two main pages: (i) Project - How to improve the city you live in? and (ii) Python and Spreadsheet - Basic Course.

The goal of (i) was to aggregate the information about the project since the pillar of the course was the ProjBL methodology. There were contents to help the students understand better and develop the project, such as an explanation of fundamental concepts, content on how to manage a project, guidance to choose the theme and how to find the necessary data.

Page (ii) had the focus on providing content about programming, being the "Need to know" list of Larmer, Ross e Mergendollar [7]. The Moodle platform was separated into sections where each represented one topic below, following the same order:

- Introduction to Google Environment: Documents, Slides, Spreadsheet and Collaboratory
- Math Operation in Spreadsheets and Python
- Concept of Variable
- Concept of Input and Output
- Using Functions and Libraries
- Creating Functions
- Introduction to Data Type: numbers and strings
- Data Type: Lists
- Plot Graphs in Spreadsheet and Python
- Data Type: booleans and Conditional
- Loops
- Data Type: dictionaries
- Library: Numpy[2] and Pandas[3]
- Library: Streamlit[4]

Depending on the topic, the students had text or video to follow in order to understand and complete the assignments. With this knowledge, the students will have an introduction to programming logic and introduction to data analysis, especially due to the use of libraries such as Matplot.lib[5] and Pandas. By the end of the course, the participants were challenged to use the Streamlit library to create a website to showcase their findings and results. With the structure of the course defined it was time to select participants.

[1]https://moodle.org/?lang=pt_br
[2]https://numpy.org/
[3]https://pandas.pydata.org/
[4]https://streamlit.io/
[5]https://matplotlib.org/

4.3 Evaluation Design

To evaluate the experience of the students on the course a questionnaire survey was initially planned. However, in the data analysis of the questionnaire, there was a tendency for the students to give good feedback. So, to go deeper with the evaluation, a couple of students were invited to interview sessions. This section describes the design of the artefacts used for evaluation. First will be presented the questionnaire and then the interview.

The questionnaire was based on the work of Mello and Mello [8]. In their research, they report the experience of organizing, implementing and evaluating a course for undergraduates. The evaluation process happened through a questionnaire with the students. Due to the similarity of the research was seen as an opportunity to use the questionnaire as a reference to craft the one used in this paper. The survey was designed with five parts:

(1) Consent term: let the participants know the implications of their participation and check if they consent to participate;
(2) Participant Characterization: understand students' characteristics and how their individual traits might influence their course experience, and consequently, their evaluations using closed questions with "Yes" or "No" answers;
(3) Previous Knowledge: the objective of this phase was to determine whether the students had prior exposure to Spreadsheet or programming content, as this could impact their learning experience. This was accomplished by employing statements and a Likert Scale for their responses;
(4) Acquired Knowledge: in this part were presented 20 affirmations for the participants to self-assess their learning through Likert Scale answers;
(5) Evaluation and Impact of the Course: the goal was for the students to evaluate the project of the course, and the resources used, suggest improvements for the course and report the impact on their lives. There were a mix of questions, some being closed, Likert Scales, and some open questions.

The questionnaire was implemented using the Google Forms[6] software and it was planned to be applied in the last class, after the final presentations to not pressure students to answer with the fear that this would influence their performance.

After the analysis of the questionnaire, there was a need to go deep into some aspects, so a semi-structured interview was planned. Due to the time frame, only three students were chosen. The criteria used were the three most engaged students in class, given the observation of the NGO staff and the educational monitor who kept up with the students throughout the course duration. The interview[7] was separated into five parts:

(1) Introduction: has the goal to put the participant at ease, thanking their presence and especially asking if they consent to the interview being recorded;
(2) Model of the course: questions about the laboratory structure, flipped classroom and online synchronous classes;
(3) Resources: ask their thoughts on the available course materials;

[6]https://github.com/lagaleno/dados-t1ia-python/blob/main/survey/survey-questions.pdf
[7]https://github.com/lagaleno/dados-t1ia-python/blob/main/interview/interview-script.pdf

(4) Project: understand their perspective on developing the course project and if they saw value in it;
(5) Conclusion: asks for improvement suggestions, feedback, and checks if they want to talk more about the course.

Since it was a semi-structured interview, some questions popped out during the session and so were annotated in the script to ask the other participants if possible. The invitations were through message apps, also was sent a consent form[8] to be answered before the session, and the sessions happened with the Google Meet platform using a record application. The results of these evaluations will be discussed in detail in section six.

5 THE COURSE

With the course content, structure and evaluation designed the next phase was initiation. The first step was to select students, a selection process was employed to find a maximum of fifteen interested students. This selection process will be outlined in the subsequent subsection. After the student selection, the course officially started, and the details of this implementation phase will be elaborated upon in the following subsection.

5.1 Students Selection

To select students to compose this first class of the course there were three stages: marketing to the public, applying, and a group interview. The goal was to have fifteen students, maximum, who showed interest in learning and were proactive in solving problems and concluding tasks.

The NGO was responsible for marketing, they made publications on the local news and directly contacted public schools to reach the students. A Google Form[9] was made available for the students to show interest. This form aimed to get to know them and, primarily, understand if they were aligned with the course proposal. For example, they were questioned on their interest in enrolling on the course, what topics they are interested and if they do any extracurricular activities. There were 31 respondents, 20 were selected: 17 high school students and 3 employees from the NGO (the CEO personally asked for them to be part of the class).

To conclude the selection process a group interview was organized with the 20 participants to check their proactive to solve problems and teamwork. There was a script[10] with two activities: an introductory for participants to get to know each other, and the other to work in a team and, together, make a plan to solve a business problem. Of the 20 invited, only 13 appeared, and due to their behaviour, all were selected to be part of the course. Of these 13 individuals, 10 were from the second year of High School, with 3 of them identifying as girls and the other 7 as boys, and 3 employees as all boys.

5.2 Course Implementation

Classes started in July/2022 and went until November/2022. There were two synchronous classes with a teaching assistant (first author of this work) with a duration of one hour and thirty minutes, on Tuesdays and Thursdays from 6 PM until 7:30 PM. Due to distance, the course followed a hybrid format, with the students being in person in the NGO laboratory (image 1) and interacting with the teaching assistant through Google Meet.

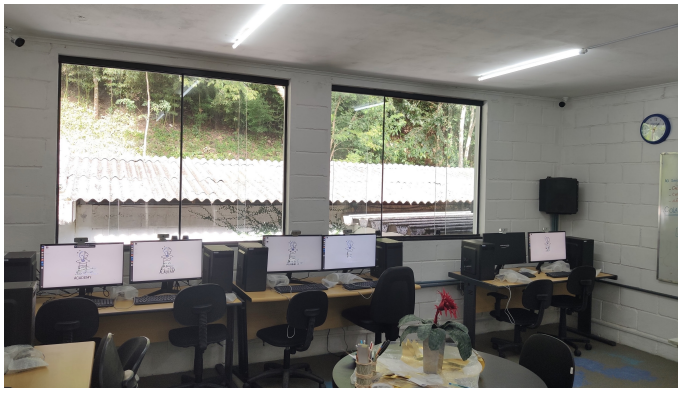

Figure 1: NGO Laboratory

The first class was introductory, in which the students presented themselves, the course staff presented the syllabus and the goal of the course, explaining the Project. By the end of the first class, all students already had a group to work on. Although Larmer, Ross and Mergendollar [7] express that for ProjBL, the ideal size for a group, due to the number of students, the size chosen was a minimum of three and a maximum of four students. This way, initially, there were four groups (one being with four students and the other with size three).

Each synchronous class had the goal of being a comfortable environment for students to ask questions, do exercises, and develop the final project. From one class to another the students were assigned to study a specific topic available on the Moodle platform, minding the Flipped Classroom methodology.

On every Thursday the weekly form[11] was sent to students, to accomplish the Review and Reflection of ProjBL. It wasn't an anonymous form and it wasn't mandatory. However, the teaching assistant used the final minutes of the class to ask to students to answer in order to have the most feedbacks possible. In total were 19 forms, with week 8 having two forms since a mass of students showed signs of giving up. The feedbacks made it possible to diagnosis problems and come up with activities to engage students. For example, because of technical difficulties reported, it was thought of gamified quizzes wit the "Kahoot!" platform[12]. Also, to address the misconception that students were not considering a career in the technology field, professionals from the technology industry were invited to create videos sharing their personal stories. In these videos, they highlighted how they overcame challenges in their careers. Additionally, a synchronous class was dedicated to the theme of "Working with Technology," during which the teaching assistant addressed and clarified any doubts students had.

[8] https://github.com/lagaleno/dados-t1ia-python/blob/main/interview/interview-consent-term.pdf
[9] https://github.com/lagaleno/dados-t1ia-python/blob/main/students-selection/application-form.pdf
[10] https://github.com/lagaleno/dados-t1ia-python/blob/main/students-selection/group-interview-script.pdf
[11] Folder with forms and it's answers: https://github.com/lagaleno/dados-t1ia-python/tree/main/weekly-feedback-form
[12] https://kahoot.com/

Halfway through the course, the groups presented their evolution on the project. This event was named the "Intermediate Challenge" or "Challenge 1" for the participants. The students were tasked to have at least some Python code that could plot a graphic with the data they found regarding their chosen theme. Employees from the NGO and Professors from the university were invited, so they could improve their 21st-century skills [7]. The groups could get feedback on their technical work and public speaking abilities to improve the last presentation.

Following this moment the students focused on improving their code and applying further knowledge they gained through the rest of the course to deliver the full project, which was known as the "Final Challenge". The final presentation occurred again with outside people invited, and the groups were able to showcase their final results, analysis of the data, website, and an answer to the proposed question. Images 2 and 3 are examples of the project's final product, websites developed using the Python library Streamlit.

Figure 2: Example of website developed of one group

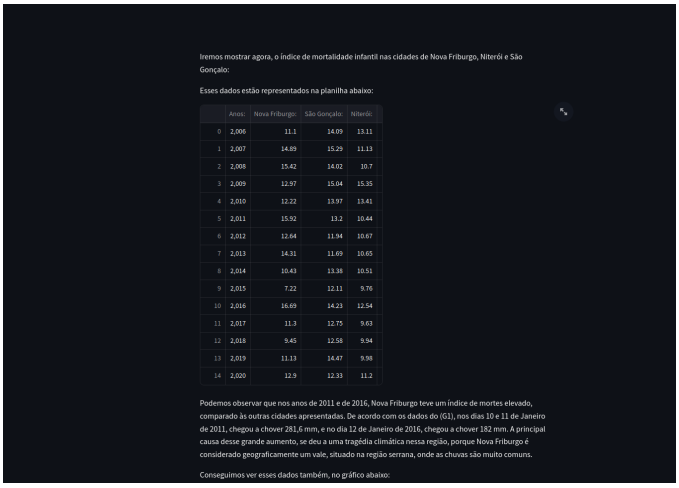

Figure 3: Example of website developed of another group

The last class was on November/22. Of the 13 participants, only 10 concluded the final project (with 9 being high school students, with 2 girls, and only one employee remained). Also, in the last class, after the presentations, the students were asked to fill out an anonymous survey, and after the graduation ceremony, three students who stood out, based on the teaching assistant and NGO staff observation, were invited to participate in interviews. The next sections will go into detail about the results of the course, based on students' experience.

6 COURSE EVALUATION

Out of the initial 13 students, 10 completed the project, meeting the minimum attendance requirements to earn their certificates. Out of the three students who gave up, two were NGO staff members and one was a high school student. Following the final project presentations, the students were invited to take part in a comprehensive course evaluation. It's worth emphasizing that this course evaluation occurred after the course had formally concluded, allowing participants to provide honest feedback without concerns that it might negatively impact them.

The goal of the evaluation was to gain insight into the students' perceptions of their course experience, ascertain whether they had successfully acquired the course material, and assess the effectiveness of the teaching methodologies employed. The next subsections will go into details about both survey methodologies used and their results, to conclude there will be a discussion regarding the data collected.

6.1 Questionnaire

The questionnaire was sent to the participants in the last class and assured that it was optional and anonymous with the note they had three days to reply. At the end all 10 students replied[13]. The primary objective of the questionnaire was to gather the student's views on their growth and feedback on the course. The questionnaire was divided into five parts. The first was a consent term in which if the students chose to continue they automatically agreed. The other sections' results will be described below.

6.1.1 Participant Characterization. It was relevant to understand in what conditions the students lived while attending the course, so it was asked: (i) had access to a personal computer and (ii) if they worked. Both were closed questions with "Yes" or "No" answers.

Question (i) revealed that two students did not have a computer available besides the ones in the laboratory, which shows that the lab space was crucial for some students to complete the course. Question (ii) showed that three students needed to work while studying (one is the NGO staff and two high school students), this information is important to understand how the workload outside the course could have impacted their performance.

6.1.2 Previous Knowledge. In this part of the questionnaire it was used a Likert scale with four levels of agreement (Totally Agree, Partially Agree, Partially Disagree and Totally Disagree) to measure the previous knowledge of the students before starting the course. Table 1 shows the results obtained.

[13]Raw data of the survey: https://github.com/lagaleno/dados-t1ia-python/blob/main/survey/raw-survey-data.xlsx

Table 1: Participant Responses

Questions	TA	PA	PD	TD
I already had knowledge of Spreadsheets before taking the course.	1	7	0	1
I already knew Programming before taking the course.	1	2	2	4
I already knew Python before taking the course.	0	2	0	7

6.1.3 Acquired Knowledge from the Course. At this moment the participants were invited to release a self-assessment regarding the topics studied in the course. It was twenty affirmations that they would rate their agreement following the same Likert scale already cited. Table 2 shows the results.

Table 2: Responses

Questions	TA	PA	PD	TD
I understood how to create a spreadsheet to display data.	10	0	0	0
I understood how to use formulas in spreadsheets.	7	3	0	0
I can create graphs in Spreadsheets.	9	1	0	0
I understood the concept of Input and Output.	9	1	0	0
I understood the concept of Variables.	9	1	0	0
I understood how to perform mathematical operations in Python.	9	1	0	0
I can use functions in Python.	8	2	0	0
I can use Strings in Python.	7	2	1	0
I can use Lists in Python.	7	3	0	0
I can use Booleans in Python.	5	3	2	0
I can use Relational Operators (==, >, <...) in Python.	6	4	0	0
I can use logical operators (and, not, or) in Python.	6	4	0	0
I can use if/else in Python.	7	2	1	0
I can use repetition structures (for, while) in Python.	6	3	1	0
I can use dictionaries in Python.	8	2	0	0
I understood the concept of libraries in Python.	9	1	0	0
I can create graphs in Python.	9	1	0	0
I can use Pandas to work with data.	6	3	1	0
I can use Streamlit.	7	2	1	0

The students' responses indicate a strong tendency to agree with most of the statements. It's worth noting the result regarding spreadsheet content: since the majority marked that they had previously had contact, ease throughout the course was expected. Additionally, the introductory Python content and the use of libraries received good evaluations. On the other hand, there was a certain difficulty pointed out with Boolean content, which may have been reflected in subsequent content, such as conditionals and loops. In class, there was a noticeable greater difficulty and resistance in understanding repetition structures.

6.1.4 Evaluation and Impact of the Course. This section of the questionnaire was a mix of different types of questions, some being closed questions (Likert Scale, rating, and with options to choose from) and, by the end, some open questions. To evaluate the course material, laboratory infrastructure and satisfaction of the students with the project the participants were asked to rate between 1 (very bad) and 5 (very good). Table 3 shows the mean of the answers.

Table 3: Rating Answers

Questions	Mean
Course material regarding spreadsheets	4.3
Course material regarding Python	4.6
Moodle Platform	4.1
Infrastructure of NGO Laboratory	5.0
Having the NGO Laboratory available to access the online platform and attend classes	4.9
Motivational vídeos from people of the technology field telling their story	4.8
Quizzes on the Kahoot! platform	4.9
Develop the Intermediate Challenge (Challenge 1)	4.6
Develop the Final Challenge (the project)	4.5
Day of the final presentation	4.7
Make the course challenges in group	4.4
Have a fixed group	4.1

In general, the mean of the answers is high. However, when questioned about the Moodle platform one student answered 1 and two students answered 3. The same happened in the evaluation of having a fixed group throughout the course, and it's important to notice that when questioned about making the coursework in group one student answered 1. The course material about spreadsheets received bad grades, having three participants choose 3 as an answer. As seen in the Table 3 the NGO laboratory structure had a mean of 5 and when the students were questioned about their frequency two students answered two times and the other eight answered three times, showing that the students were there even though they didn't have classes. The Likert Scale questions were regarding the interest of the students in doing the project, eight students totally agreed that doing the project helped in understanding the subject of the course and two partially agreed. To end the closed questions, it was asked if the students continued studying programming and had an interest in pursuing a career in computer science. Table 4 shows these results.

Table 4: Future in Programming

Questions	Yes	No
Continue studying programming	10	0
Pursue a career in programming	10	0

The open questions were about the difficulties and points the course could improve. The main difficulties pointed out were: mathematics, the programming language itself, time management, English, and night classes. When asked about points of improvement the highlights were: Saturday classes, more group work, content revision in class, and an expense allowance to help with student transport.

6.2 Interview

Although the questionnaire answers gave great insight into the experience and students' thoughts on the course, the overall great responses in almost all aspects showed the researchers that interviewing the students could be advantageous. Due to the time available, a semi-structured interview was planned with the three most engaged students.

To analyse the data[14] gathered by the interview, theme analysis methodology was employed, stopping at level two of the analysis (codification and categorization) using Google Spreadsheet. The answers of the participants (p1, p2 and p3) generated 66 codes. To categorise them it was made an inventory to get categories, were 12:

- Frequency in the laboratory outside of class hours
- Frequency in the laboratory during classes
- Laboratory infrastructure
- In-person support
- Course model
- Class model
- Presentation of content
- Course contents
- Course project
- Intermediate Project execution
- Group work
- Future in Programming

In five categories p1, p2 and p3 had similar opinions. Table 5 describes these categories putting aside the analysis of the research and a participant citation. It's important to note that the interviews happened in Portuguese and the quotes were translated to English to fit this work. These categories express to researchers that the Laboratory environment and the presence of an NGO staff member through classes were crucial for the students in completing the course. It's important to note the good comments on the content presentation, especially when video was used, which was something highlighted for the flipped classroom to succeed. Also, the interviews reinforce the results about the future of the students regarding the technology field.

In contrast Table 6 shows the other categories that some participants diverged in opinions following the same structure. From these categories, it's important to notice the course model and course project. The course model category mainly talks about the usage of Flipped Classroom, which can be seen that did not have a consensus and one participant expressed a dislike for this methodology arguing there could be a moment of revision of the content in class. For the course project, although two participants expressed their enjoyment in developing one participant stated that the exercises were enough and the project was confusing.

With this analysis, it was possible to compare with the questionnaire results and get conclusions about the experience of the participants. This will be discussed deeply in the next part.

6.3 Discussion

Given the data collected through the surveys applied it was possible to understand the student's perception of their experience and acknowledge their views on the course.

When questioned about the NGO laboratory in the questionnaire, in general, the students praised its infrastructure and the possibility of using it throughout the course. The same happened in the interview, which showed how the in-person support was a key factor for the students to have a great experience. With these results, it is observable that having the active support of the NGO, through the laboratory, a staff near, and computers available to study besides the class hours.

From the questionnaire, the model of the course (being hybrid, flipped classroom, teamwork) received good evaluations, in general. However, with students answer in the interviews it was possible to see some flaws. For example, participants criticized the use of flipped classroom, arguing that a mix of active and passive learning could benefit the class, suggesting revision of the content before the active part of the class. Although the flipped classroom was the chosen methodology, from the feedback received it's shown the need for adaptation for next classes with this target audience.

The hybrid format appeared to make the process of learning more difficult. One participant in the interview exposed that the in-person help of the educational monitor could have helped more throughout the course. The group work was an aspect that received low grades from the questionnaire participants and, in the interview, some participants expressed the reason: the group did not balance the workload well, with some being overworked. Even though it's not possible to completely change the hybrid format, due to the distance between the cities of the educational monitor and the NGO, it's seen the need to provide in-person specialised assistance. For example, invite graduated students of the course to provide this help for the next generations.

Through the self-evaluation on the questionnaire, students stated they could learn most of the subjects proposed by the course. In the interview, the participants contributed to this vision, stating that the presentation of the content was good.

Surveys showed that the execution of the project, in general, helped in the learning process, solidifying the course content. However, in the interview, one participant expressed difficulties in doing the project, especially in conciliating the execution of the project and studying the content for the course. This shows the necessity of better planning of the course, to ease the process of doing the project and connecting more with the subject of the week.

[14]Raw interview data of each participant: https://github.com/lagaleno/dados-t1ia-python/tree/main/interview

Table 5: Categories with Shared Ideas

Category	Interpretation	Participant Citations
Frequency in the lab during classes	All participants agreed and saw value in having the lab environment to attend synchronous classes	"I really liked it; I think having a specific environment for that also helps with concentration because sometimes being at home gets more complicated and distracting. So, everyone was there for the same thing, it was cool." - p2
Laboratory Infrastructure	All participants stated that the lab offered good infrastructure for conducting activities	"It was all very perfect, like everything 100%, all the materials, the brands, everything. All peripherals from a good brand, reputable brand." - p1
In-Person Support	Participants pointed out that having someone in the lab assisted the course experience, helping them stay focused and, for some, not to give up	"I think alone, I think it would be a bit messier. I think it would be too messy, and <NGO employee>was there to bring order." - p3
Course Presentation	Students noted that the presentation of the content was satisfactory, with two emphasizing that video content was better for understanding the material	"I liked it, and what I also think, and I mentioned this to you, the videos, for me, are nicer because it's a way that I learn better, so I found the classes with video materials better than those with only reading. And those that had more than one option, like, if I'm not mistaken, this way has another person who explains in such a way." - p2
Future in Programming	All participants said that, after the course, they are interested in pursuing a career in programming	"I think, after doing this, I really think it was something that I fit into. I liked participating and liked the content." - p3

To conclude the evaluation the participants were questioned their interest in continuing their studies and pursuing a career in computer science. Due to the answers, it was seen that the course aroused the interest of some students in technology.

7 CONCLUSION

This paper presented an educational experience of crafting a Python course using active learning methodologies, such as Project Based Learning and Flipped Classroom, for high school students.

An NGO from a city in the state of Rio de Janeiro saw an opportunity to qualify the young labour force in the city to work in the technology field and raise their interest in technology, due to the employability scenario. With that in mind, the NGO established a partnership with a public university to conceive a course to teach the basics of programming to high school students. Thus the target audience, it was used active methodologies to engage students in the learning process. It was chosen to use the Project Based Learning combined with Flipped Classrooms. Because of the results reported on related works, it was expected a good outcome.

The course started with 13 students and 10 graduated, completing the project. By the end, they were invited to evaluate their experience, by a questionnaire (that all 10 answered) and interviews, in which three were invited to participate. The results showed evidence that the course was a success from the perspective of students. Through self-assessment, they conveyed their understanding of the provided content and highlighted how the project development process assisted in reinforcing the concepts they had studied. Also, they praised the laboratory and expressed the importance of having it available to watch classes and study. To conclude, all 10 students showed interest in continuing their studies in programming and pursuing a career in the technology field. In the interview sessions, students reinforced this and some expressed that the course opened their mind to a career in computer science.

Although the results indicate the success of the implementation of active learning methodologies for programming logic with Python to high school students, there are some limitations. Due to the space and computers available in the laboratory, there was a maximum of fifteen students to attend the course, which led to a reduced class. To reinforce the result it's necessary to replicate the course with other groups of students and larger classes. Also, there was a limitation on the evaluation. Because of the timeframe, it was not possible to interview all 10 students which led to choosing a more reduced group. The criteria chosen were the most engaging students. The researchers understood they could valuable and honest answers, which could produce less biased results.

To continue this work the researchers pretend to: craft a second course with the same students to teach the basics of front-end development (HTML, CSS, and JavaScript) also using ProjBL and Flipped Classroom, to keep them interested in programming; form a new class to replicate this Python course with the improvements needed given the students feedback; make a course focused in minority groups in computer to promote diversity in the field; and record the contents so it's not needed to use the ones available on the internet and keep the quality of the content.

Thus, this project sought to make a meaningful contribution to the teaching of programming logic for high school students. Used active teaching methods designed to captivate this specific audience, infuse a practical dimension into the classroom, and empower the students to own their learning journey using Project Based Learning.

Table 6: Categories with Disagreements

Category	Interpretation	Participant Citations
Frequency in the lab outside class hours	Two participants saw value in having the lab available in the afternoon, for example, in addition to the scheduled class time. However, one of the participants found the idea interesting but couldn't be present due to work, so didn't see much sense in the initiative	"So I couldn't go in the afternoon, I could only go after my work, but the idea is very good for those who could go. People were going there, like <student's name> and <student's name> who were always there studying a bit before, always arriving early and so on. But I admit that for me, it worked better to stay at home because I have my computer with my things and everything already set up. But I think the idea is cool." - p1
Course Model	Participants disagreed about the course model, the flipped classroom. For example, P2 saw value in the initiative as it was different from school; however, P1 argued that classes with the teacher explaining were better, while P3 believed that a blend of methods would be ideal for him (having the content available beforehand but explained again in class)	"you put in a lot of effort, in the beginning, to try to understand, and then what you don't understand, the teacher explains. And what you learned on your own is already a profit." - p2 "For me, it didn't work, mainly because I don't have much time to learn at home, to stay on top of things at home. I'm always at work or somewhere, and then it's easier for me to do it at home from time to time." - p1
Class Model	In addition to issues with the course structure itself, students expressed disagreements about the Tuesday and Thursday classes. Apart from the question of having a review or explanation, one of them pointed out that having in-person support in the lab would be a facilitator and motivator for the course, while others stated that the model with the remote teacher did not affect their learning	"I liked the model, but I think it would be better if the professor were there, right? As many times, there was someone who was responsible for teaching some people from the company. He was a programmer, and we were there, programming. And then <name of another student> came. He came up with ideas, which I found interesting." - p3
Course Content	Participants pointed out different contents that they had difficulty understanding and which could be improved. While one participant claimed not to have had difficulty with any specific content	"I know negatively it was Loops, God forbid, this thing is bad until today, I still have difficulty with it. Then, I really didn't have any difficulty with anything. Everything was easy for me, lists, dictionaries, and normal math for debit, like plus, minus, division, percentage, everything was fine." - p2
Course Project	Two participants claimed that the project helped solidify course content, while one of them said the project was not helpful for this, not being necessary, and that the exercises were sufficient	"It's a topic that's very open, and then, as we needed tables, we needed to use tables, Matplotlib, I was focusing a lot. I learned a lot in the Python part. And then, when it was time to do its data, both in the intermediate and in the final, it was difficult." - p1
Intermediate Project Execution	Again, two participants agreed that completing the intermediate project assisted in their studies and facilitated the resolution of the final project. However, P1 does not agree that it was useful	"This was a very cool point because it was kind of like a test. So you had the opportunity to use what you had learned up to that point and have an idea of how it would be for you to be much more prepared for the final. So I thought it was cool too." - p2
Group Work	While two participants expressed a preference for working alone and found it difficult to deal with the group or had a heavy workload of tasks, one of the participants said the experience was amazing and added to their learning	"many times we had a question, and someone else would come and say, 'Is it this?' But is it really this? Let's try it.' And then he came, and it worked. I think that working in a group is better. I think each one can encourage themselves, you know, be very motivated." - p3

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