Experience of Video Classes Related to Mobile Development Produced by Multidisciplinary Students Who Used the Challenge Based Learning Methodology

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Abstract— **In Brazil, many people cannot speak English and at the same time there is increasing interest in learning mobile development. Depending on the subject, it is easy to find good video classes online in English in the form of tutorials and even more traditional lectures from top universities. However, the same is not true for videos in Portuguese, which are scarce and often times poorer in quality. From that scenario, there is a great opportunity to create video classes in Portuguese with high quality that can impact the community interested to learn mobile development. Aiming to help the community, this paper presents the experience of an activity, which requested the creation of video classes covering topics related to mobile development from two multidisciplinary groups of students coming from different courses at a university in South America. These videos aimed to be short and offer direct explanations using practical examples. That group of students learned to develop mobile applications using the Challenge Based Learning (CBL) methodology, which provides an efficient and effective framework for learning while solving real-world challenges. This experience shows how different approaches used to present CBL impacted the creation of videos, and how the offered activity contributed positively to the learning of the students and the mobile community in Brazil.**

Keywords-challenge based learning; video classes; multidisciplinary groups; mobile development.

I. INTRODUCTION

The Learning Pyramid [1][2] approach of study, also known as "cone of learning", developed by the National Training Laboratory, suggests that most students only remember 5% from traditional lectures and 10% from what they read from textbooks. On the other hand, students retain nearly 90% of what they learn through teaching others. According to [1], active activities (e.g., to practice doing and teaching other people) help to better retain contents than passive activities (e.g., lecture and reading). Following that idea, there are several new learning methodologies [3]-[5] that look for a more fulfilling learning journey for students. One of these methodologies is Challenge Based Learning (CBL) [3] created by Apple in 2008. CBL fosters learning while solving real-world challenges. In order to create learning opportunities, CBL offers a framework that motivates collaborative work among learners to identify big ideas, ask thoughtful questions, and identify, investigate and solve challenges. According to [3], this approach helps students gain deep subject area knowledge and develop the necessary skills to thrive in an ever-changing world.

This paper describes learning experiences with two multidisciplinary groups of students, who came from different courses (e.g., computer science, engineering, law, design, communication etc.) from an activity which requested the creation of video classes related to themes about mobile development. Both groups were participating in an educational program that taught how to develop iOS apps [8] using CBL.

As many students did not have any previous programming knowledge, an additional motivation was to leave them to choose the theme for the video. However, the requirement of being a subject related to mobile development in some way had to be respected – examples ranged from creation of sounds to apps to publishing an app in the App Store. According to CBL [6], students have to be engaged to learn something. Thus, that freedom to choose a theme was a strategy to engage them.

Another motivation to offer such activity was to produce content in Portuguese that could contribute to the community interested to learn more about mobile development. According to [7], only around 5% of Brazilians state they have some knowledge of English. Considering that scenario, the second requirement for the activity was that all video classes should be in Portuguese. Beyond describing how that activity was offered, the paper explains how it contributed to the learning of the students, how CBL influenced the video classes created, and which additional impacts happened from these new contents.

This paper is organized as follows. Section II presents an overview of the CBL methodology. Section III describes the profile of each students group that participated in the activity, beyond explaining how that activity was offered. Section IV presents results collected from the activity and discusses this data. Lastly, Section V presents the final considerations about the work performed.

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II. THE CHALLENGE BASED LEARNING (CBL) METHODOLOGY

According to [6], CBL provides an efficient and effective framework for learning while solving real-world challenges. The framework is collaborative and hands-on, asking all participants (students, teachers, families, and community members) to identify big ideas, ask good questions, identify and solve challenges, gain deep subject area knowledge, develop 21st century skills, and share their experience with the world.

CBL is based on the foundation of experiential learning and is divided into three main phases [6], Engage, Investigate, and Act, which are explained below.

- **Engage.** Learners move from an abstract big idea to a concrete and actionable challenge using the Essential Questioning process. This process allows the generation of a variety of essential questions that help learners to think about personal interests and needs of the community. At the end, one essential question should be chosen. From this question a Challenge turns it into a call to action to learn in detail about the subject.
- **Investigate.** The learners plan and participate in a journey that builds the foundation for solutions and addresses academic requirements. This phase begins generating Guiding Questions (GQs) related to the Challenge. GQs are questions that need to be answered to allow the development of a solution. The necessary action that allows answering some GQs is called guiding activity (e.g., interviewing an expert in a specific area, reading some book etc.). At the end, learners analyze the data and consolidate the knowledge acquired from the research.
- **Act.** In the Act phase, learners already have a solid foundation to begin developing solution concepts. After the approval of this solution concept, learners develop prototypes, experiment and test. These actions can contribute to raise new guiding questions that need to be answered in the next steps to be performed. Thus, learners can return to the investigate phase to complete the research. After developing their solutions, learners implement them, measure outcomes, and reflect about the work. The refinement of the solution can go on until learners are satisfied.

Throughout the challenge, learners document the experience using audio, video, and photography. This ongoing collection of content provides the resources for reflection, informative assessment and evidence of learning.

III. CREATION OF VIDEO CLASSES

In this section, we describe how the activity to create video classes was offered for two groups of students. Thus, this section is organized as follows. Subsection A presents the profile of the participants. Subsection B describes when and how the activity was executed with the first group, while subsection C describes the application to the second group.

A. Participants

Both groups engaged in the activity of creating video classes while they were part of an educational program, which taught how to develop iOS apps. Each group participated during two years of the program and they were required to be dedicated 20 hours per week. Hence, that activity was offered during two years of program.

The first group, which received the activity, had 37 students coming from different courses, as shown in Table I. That group began their learning journey in February, 2016 and ended in December, 2017. Every week students were mentored by four teachers (3 related to computing and 1 designer), who guided them and provided additional support throughout their learning process.

TABLE I. GROUP 1 WITH 37 PARTICIPANTS

Courses	Amount
Business	1
Chemistry Bachelor	1
Computing	16
Communication	1
Design	10
Civil Engineering	1
Electric Engineering	2
Mechanic Engineering	1
Law	1
Production Engineering	3

The second group of students had 38 people. Like the first group, these students also came from different courses and were mentored by the same teachers. Their participation began in February, 2018 and ended in December, 2019. Table II presents which courses these students came from.

TABLE II. GROUP 2 WITH 38 PARTICIPANTS

Courses	Amount
Architecture	1
Business	1
Computing	16
Communication	1
Design	10
Chemistry Engineering	2
Control and Automation Engineering	1
Mechanical Engineering	1
Production Engineering	5

B. Approach Applied to Group 1

Aiming to explain when and how the activity of creating video classes was offered to the first group, this subsection is structured in three parts: (i) first, it is contextualized how the students were using the CBL methodology, before receiving

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the activity; (ii) second, it is explained when and how the activity was offered; and (iii) third, it is described how and which data related to that experience were collected.

1) CBL application: When students began the program, they were presented CBL in a lecture, which explained each phase and the vocabulary of the methodology (e.g., big idea, essential question, challenge, guiding questions etc.).

Before receiving the activity, students participated in several challenges ranging from 2 weeks to 3 months. Each challenge had different group formations, such as, free, respecting a maximum number of members per team (3 or 4 people per group), teams with people who never worked together before, groups pre-defined by teachers considering the profile of the students (e.g., course and knowledge of programming) etc. Hence, the main goals of the challenges were: providing different learning and practical experiences, engaging students to exchange knowledge between them, learning technical and soft skills to be a world class iOS developer, and enjoying their learning journey. Considering that context, the term challenge was used to refer to the activity of creating video classes.

In order to put students' autonomy, proactivity, and flexibility solving issues to test during challenges, teachers avoided giving immediate answers to questions asked by them. The approach adopted was to recommend resources and ask questions that could motivate them to research and start questioning themselves about how to find the desired answers. These issues mapped were used by teachers to make new lectures, which could help students by providing additional context after having an actual experience with that topic during the challenge.

2) Video class activity: The activity was offered to students twice. The first time was in July, 2016 and the second in July, 2017. The requirements of the activity defined by teachers and presented to them were the following.

- Choosing any theme related to mobile development;
- Validating the theme chosen with at least one teacher;
- Creating at least one video class;
- Respecting the maximum of 10 minutes per video;
- Creating videos in Portuguese, with practical examples, and avoiding explanations with slides with a lot of text;
- Choosing to work alone or with some colleague;
- Creating and delivering a document that described their CBL process was not necessary. During all previous challenges, such document was requested to students. Thus, that was an important difference.

Considering that one of the main goals was to contribute to the community interested to learn more about mobile development, a YouTube channel, called DEV PUC-Rio [9], was created to share these videos.

In order to guarantee technical correctness and good quality in the videos, a set of steps was followed by students and teachers during the activity. Below, the order of these steps is presented.

1. Teachers offered a set of resources, which students could use to create good video classes. Examples of resources were: links that explained how to use video edition tools, examples of videos classes etc.
2. Students brought themes to create videos. Teachers validated these themes 3 days after the activity was announced. In general, the themes were accepted, but a few cases (5 in total) of students with difficulty in defining some theme were identified. In these situations, teachers talked with them individually. Aiming to help them, teachers tried to identify passions that each student had. Next, some options were considered together to support their final decision.
3. Students created the first version of the video classes in 10 days. Teachers recommended students in the first two days to bring a script, which described the narrative of the video(s).
4. Teachers validated the videos delivered. Each teacher was responsible for a set of videos considering their expertise. Thus, feedback was written for each video content and shared with its creator after 7 days the first version was delivered. The main improvements identified by teachers were: (i) adjusting the sound or image presented, (ii) improving or correcting some explanation made, such as including some resource that could support it, and (iii) breaking videos in two parts, because, in some cases, they exceeded the maximum time of 10 minutes.
5. All students produced a new version of the videos. Teachers validated and offered feedback for each new version created. That process was repeated until achieving a final version for all video classes. The time it took was more than 20 days.
6. Teachers published the validated videos on the YouTube channel created. Thus, the community could access them easily.

3) Gathering data: After finishing the second activity, students received a survey with a set of questions. These questions looked mainly to understand how the experience with participating in both activities was, how they felt about the learning acquired from the activity, and if the CBL impacted the video classes created. To make students more comfortable answering the survey, it was anonymous. Below, there is a more detailed list with the points collected from the survey.

1. Time spent to create each video class;
2. How the experience to create the video classes was;
3. Learning improvement related to the theme chosen;

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4. Additional learning in topics related to video creation skills (e.g., video edition, audio edition etc.);
5. CBL influence on the final result achieved;
6. Opinion of the students regarding the usefulness of the activity to their learning.

C. Approach Applied to Group 2

Following the structure presented previously, in the current subsection we explain when and how the activity of creating video classes was offered to the second group. Here, the main differences are highlighted, such as how the second group had the first contact with CBL, how the activity was offered to them, and the approach used to gather data related to that learning experience of students.

1) CBL application: In the beginning of the program, students had a first contact with CBL in a challenge offered without having any previous lecture mentioning its terms and definitions. The main goal was to understand the methodology from the practical experience, making the process of understanding CBL more natural. Aiming to engage students and relate the challenge to their lives, the big idea (i.e., theme, area) offered was the city where they lived: Rio de Janeiro. That challenge lasted 2 weeks, and students had to propose something that could improve the city. However, to propose some solution, students must first motivate themselves for the challenge (Engage phase), perform research (Investigate phase), and propose a solution during a presentation (Act phase). At the end, the teachers informed the students that the methodology applied was CBL, and next a lecture presenting the original English terms of the methodology was made.

Similarly to the first group (see subsection III.B), the second one also had several challenges ranging from 2 weeks to 3 months of duration, different group formation strategies, mentoring with the same four teachers of the group 1, and they had the same approach to learning that involved motivating them to be more autonomous, proactive, and flexible while solving issues.

Lastly, the term challenge was not used to describe the activity to be offered. The main reason was that some students did not perform the CBL steps that would contribute with their learning. Thus, it was called as activity.

2) Video class activity: It was offered for the students once in September, 2018. The requirements of the activity and the steps adopted during its execution were the same as the ones offered for group 1. Like the first group, all students of group 2 also had to produce at least a second version of each video. The necessary changes were the same identified in group 1. At the end of the activity, the video classes were also published in the YouTube channel created.

3) Gathering data: After the delivery of all video classes, the same survey applied to group 1 was offered to the second group. Thus, the survey was answered anonymously, making students more comfortable to fill it.

TABLE III. THEMES OF VIDEOS PUBLISHED

Themes	Group 1 Activity 1	Group 1 Activity 2	Group 2 Activity 1
Publishing app at AppStore	1	-	-
Monetization	-	2	-
Disclosure of apps	-	1	-
Persistence	4	4	7
Front-end development and/or UIKit	7	10	10
Software Test or control version	1	3	-
Creative commons license	-	1	-
Autolayout and/or constraint	1	1	3
Camera and/or Photos	-	1	1
Architecture and /or code organization	1	2	3
Control version	1	-	-
Game development	7	1	2
Approaches to login	2	-	-
Concepts/paradigms of programming	2	3	1
Dependency manager	2	-	-
Accelerometer and gyroscope	2	-	-
watchOS	1	-	-
TvOS	1	-	3
Vision or Augmented Reality	-	5	2
MachineLearning and/or IA	-	1	6
Sound from Garageband	-	-	2
Learning Approach to create an app	-	-	1
Other Apple Kits	2	5	5
Total:	**35**	**40**	**46**

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IV. DATA COLLECTED AND DISCUSSION

In this section, data gathered from the survey applied to the students' groups are presented and analyzed. As group 1 had taken part in two activities related to creation of video classes, teachers requested from them answers based on both experiences. If some difference was identified, this fact would be mentioned in the survey, which offered an additional area for comments. On the other hand, group 2 considered only the single experience performing the activity offered to them.

Initially, Table III categorizes themes chosen by students and the number of videos created per category. Notice that by activity applied, i.e., two activities for group 1 and one for group 2, "front-end development and/or UIKit" was the theme with the highest number of videos created. According to [11], UIKit is a framework that provides the required infrastructure for iOS or tvOS [14] apps. It provides the window and view architecture for implementing interfaces, the event handling infrastructure for delivering Multi-Touch and other types of input to apps, and the main run loop needed to manage interactions among the user, the system, and the app.

According to teachers, having a good number of students producing videos related to front-end was not a big surprise, because many of them presented high interest about the topic since the beginning of their participation in the program. Besides, considering that some technologies had increased visibility over time, such as Vision [12], Augmented Reality [13], Machine Learning and IA, such themes also aroused great interest from the students.

Another piece of information gathered from the survey was the time spent to create each video. Table IV shows that more than 50% of the students per group spent more than 5 hours creating each video. Analyzing the information in more detail, many of them mentioned that the process of defining the script, creating materials that could support the videos, learning how to edit videos, were examples of tasks which influenced the time.

TABLE IV. TIME SPENT TO CREATE EACH VIDEO.

Options	Group 1	Group 2
Less than 1 hour	0	0
1 to 2 hours	1	3
2 to 5 hours	15	7
More than 5 hours	21	28

The survey also aimed at understanding how students felt about the experience of creating video classes for other people. Table V shows that students from group 2 considered the activity more enjoyable than students from group 1. Analyzing comments made by students from the first group, it was possible to identify that some of them were not as enthusiastic about creating content as when the first activity was introduced. That feedback was important and influenced the decision made by teachers to run the activity with the second group only once.

TABLE V. HOW THE EXPERIENCE TO CREATE THE VIDEO(S) WAS.

Scales	Group 1	Group 2
1 (not enjoyable)	1	2
2	1	2
3	10	4
4	7	1
5	9	13
6	7	10
7 (very enjoyable)	2	6

Another important piece of information analyzed was a self-assessment by the students considering their knowledge level before and after the activity was performed. From Table VI, it is possible to realize that both groups felt learning improvements in relation to the themes chosen. For instance, group 1 had 34 students answering 5 or higher, and the same happened with group 2, also with 34 students.

TABLE VI. KNOWLEDGE LEVEL PER TOPIC.

Scales	Before Activity Group 1	After Activity Group 1	Before Activity Group 2	After Activity Group 2
1 (none)	3	0	0	0
2	2	0	4	0
3	7	1	10	1
4	12	2	8	3
5	7	7	7	5
6	4	21	9	24
7 (expert)	2	6	0	5

As these activities were the first experience of students creating videos, the survey also looked for mapping which additional contents related to it, they could have learned. Thus, Table VII shows answers considering how many students considered to have a good learning in relation to the following topics: storyboard, screen capture, video and audio editing. For both groups, more than 80% of the students confirmed to have learned at least one of these topics mentioned. In addition, group 1 had more people learning these topics than group 2. Analyzing more deeply the comments offered by students and analyzing the profile of each group, teachers identified that the second group had more people with some previous experience related to video creation. Thus, it probably influenced the answers collected.

TABLE VII. NUMBER OF STUDENTS THAT AGREED TO HAVE HAD A GOOD LEARNING RELATED TO SOME TOPICS FROM THE ACTIVITY.

Themes	Group 1	Group 2
Storyboarding	3	3
Screen capture	24	12
Video edition	20	17
Audio edition	17	14

Following the idea of mapping other topics learned by students during the activity, an additional open question was offered to them. Thus, as the answer to that question students could share if they had learned something else. The results showed improvements related to development topics (e.g., object oriented programming [16],

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architecture and modularization [17][18]), beyond improvements in communicating to an audience. That was the soft-skill that was the most mentioned by the students (more than 20% per group).

The next question was more related to the learning methodology applied in the program the students were participating in. It looked to understanding what influence CBL had on the video classes created according to the students' perspective. Table VIII shows that a good part of the students considered the impact of the learning methodology minor (equal or less than 3): 23 students of the first group and 14 students of the second group. Aiming to better understand these answers, an additional area in the survey was offered requesting explanations.

TABLE VIII. CBL INFLUENCING VIDEO CREATION.

Scales	Group 1	Group 2
1 (strongly not influenced)	7	2
2	10	7
3	6	5
4	4	8
5	6	6
6	3	6
7 (strongly influenced)	1	4

After analyzing these answers, it was possible to achieve some important conclusions and learned lessons, as follows.

- According to some students from group 1, CBL would be present if some document describing the learning process was created. In all previous challenges offered to group 1 such document was requested, which could have influenced their mindsets. From that feedback, teachers realized they needed to improve how they presented the idea of the methodology instead of sharing a view that CBL depends on a formal document to be delivered during the learning process.
- In all challenges offered previously to the students of both groups, CBL vocabulary was used intensively. However, when the activity to create video classes began, these terms were not used as often by students and teachers. That approach should be improved.
- The activity was offered to the first group as a challenge. However, after talking with students and analyzing their experience, teachers realized that some students did not follow the CBL steps, such as deep research (Investigate phase) during that work. To consider an activity as a challenge, it is important to perform extensive research to help support some solution proposal. From that, teachers decided to no longer present the activity as a challenge to the second group, but simply as an activity.
- Some students, who had previous experience with other active learning/teaching approaches (e.g., project based learning [15], design thinking etc.), sometimes did not connect the steps of the CBL to the actions that they were taking, such as to answer the identified guiding questions. Only after talks with teachers, students realized this. That was an alert to improve CBL understanding.

Lastly, the survey requested the opinion of the students if the activity offered was useful to their learning. Table IX shows that group 2 thought it was more useful than group 1. However, almost 50% of the students (18 people) from the first group thought it was useful (answered from 5 to 7).

TABLE IX. OPINION OF THE STUDENTS CONSIDERING THE VIDEO ACTIVITY AS USEFUL TO THEIR LEARNING EXPERIENCE.

Scales	Group 1	Group 2
1 (strongly disagree)	3	1
2	4	1
3	6	0
4	6	8
5	7	8
6	4	8
7 (strongly agree)	7	12

After the activities performed by both groups, more than 120 videos were made available on the YouTube channel. Besides, the channel got more than 2 thousand subscribers, and became an additional reference to new editions of the educational program performed in Rio de Janeiro. When some video of the channel becomes outdated, teachers are looking to motivate the creators or new students to produce a new version of the video.

An interesting situation that happened with some students who made videos was to be recognized at national and international events of development from people, who were subscribers of the YouTube channel. Some videos achieved more than 10 thousand views in a few months, being a resource that the community has been interacting a lot with through questions and feedback.

After the participation in the program, teachers mapped on social media students who continued creating contents for the community (e.g., videos, papers etc.) or participating in events related to development (conferences, symposiums, hackathons etc.). From group 1, at least 15 people, and from group 2, at least 22 students participated in these activities.

Having students interested in producing contents and sharing experiences with other people, it is a way of contributing to the learning of more people and making the knowledge wheel spin even more.

V. CONCLUSION AND FUTURE WORKS

Aiming to contribute to the Brazilian community interested to learn more about mobile development, this paper described the learning experience of an activity related to video class creation applied in two multidisciplinary students' groups. The videos produced are available on a YouTube channel and focus on different themes related to iOS development.

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Considering that such activity was offered in an educational program that applied CBL, it was important to understand how students looked for the methodology and how teachers could improve the approach to use it.

One future work intended is to propose a translation of the CBL vocabulary, which is currently in English, into Portuguese. Thus, many students who do not master English will be able to learn from a CBL version using their native language. When an immediate translation to Portuguese is made, some of the CBL terms can be ambiguous or misleading, as some participants of the program report. Thus, performing a study that can gather feedback from beginners or more advanced learners that use CBL it a possible approach to be followed.

Another work that teachers are thinking to adopt in the program is to identify from the very beginning which students are interested to produce content in Portuguese. Thus, a possible more personalized learning track related to production of new contents could be introduced to students. Hence, offering personalized tracks is a possible approach to engage students to learn more contents and maybe contribute to the learning of other people.

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