An Open Educational Game Based on Re-Purpose for Teaching Technical English in the Context of Computer Programming at Brazil

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Abstract. Students of Information Technology (IT)-related undergraduate courses often face barriers like insufficient prerequisites for difficult subjects and lack of motivation. The completion of abstract tasks like logical thinking, algorithm design and programming often gets harder than usual, since frequently they require basic knowledge of some foreign language, explicitly English. In the context of non-native English-speaking countries, the IT students can face a specific problem of having to write programming codes using keywords and commands mainly in English; In this sense, the goal of this paper is to present the repurposing of an open-source conventional, entertainment-driven 2D game to an educational game to teach technical English, related to programming fundamentals. An alpha version of the educational game has been delivered and a subjective experiment was carried out with a sample of 42 IT students and the results of the paper show that the repurposing was done in a straightforward way.

Keywords: Game Modding, Game Remix, Open Educational Resource, Educational Game.

1 Introduction

The portuguese empire was the first world empire in history, covering almost six centuries of existence, starting in 1415. It is noted that during most of them almost six centuries, the Portuguese language had a great influence in the world [1]. Another very important empire in the history of the world was the spanish empire, which started in the 15th century and was in operation until the beginning of the 19th century. It cannot be denied that the Spanish language also had an enormous capacity

in the world. This helps us to understand that, during this period from the 15th to the 19th century, if people wanted to communicate globally, what would make more sense would be the communication in Portuguese or Spanish [2, 3].
Today, what they define as great powers are no longer wars over territories, ships and exploratory trips by oceans, etc., but technology, within this great area, known Information Technology is of great importance. As can be seen in [4, 5, 6] English is currently the most widespread language in the world. It is a fact that all high-level Computer Programming (CP) languages work with instructions in English, which means that the best and / or most updated information technology materials are produced and used in English and later translated into other languages, but with an inevitable delay. According to [4, 5, 6], the most important scientific research is written in English.
According to [7] studying programming is difficult for most students starting higher education courses in IT, in poorer and / or emerging countries, students do not necessarily have basic educational content and learn at a very fast pace.

2 Theoretical Fundamentals

2.1 Teaching and Learning CP and Dependence on Technical English.

According to [8], learning CP offers a set of challenges and techniques that are different from the challenges of learning Physics or Reading / Writing.
CP is one of the pillars of Computing. The teaching of CP is one of the biggest challenges that have been faced for years in Computer Science; a particular case is the teaching of CP for beginning students [9]. The student's interest in the subject is an important topic, learning programming will be boring and difficult if students are not motivated or engaged [10]. The challenge of learning and teaching CP is exacerbated by the traditional reading-based approach [9]. English is often the language of instruction in the university classroom; the best and most current books and articles are commonly published primarily in English, the job market values the command of English and most MOOCs (Massive Open Online Courses) are available in English [11].

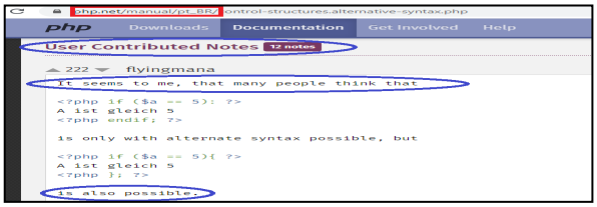

Fig. 1. PHP language documentation with English texts

The difficulties in studying programming, including difficulties in the English language, can make students unmotivated and even withdraw from the course. Fig. 1 shows the official Brazilian website for the online documentation of the PHP

programming language, it is possible to see that even though the website is Brazilian, there are explanations about the language that are documented in English.

Fig. 2 shows a text generated by the Python interpreter to explain an error generated in a program. These errors shown by IDE are presented in English. It is very common that many programming students who face this type of situation do not even try to understand what error is occurring, but ask the teacher for help immediately, often due to the great difficulty of reading and interpreting a simple text in English.

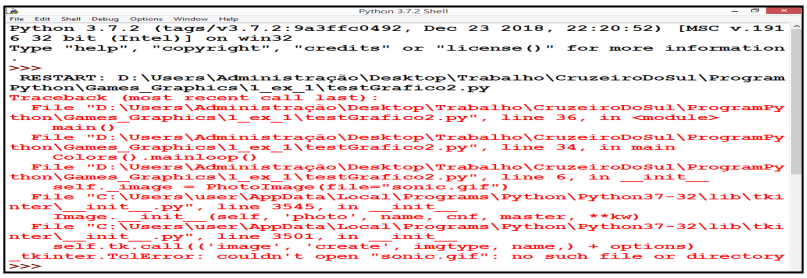

Fig. 2. Error description, in English, in the Python interpreter.

In addition to the examples of situations that the CP student needs technical English to deal with the discipline, there are other situations that even include the reserved words of the languages that also belong to the English language.

2.2 Learning and Proficiency in English in Latin American Countries

In countries that do not speak English officially, most students have poor English experience and are unable to communicate or write fluently in English [8].
According to [11] approximately 95% of the world population do not have English as their native language, which contrasts with the issue that approximately 100% of programming languages are defined in English, for example. English is the official language of many open-source software communities around the world.
As a result of Spanish colonization in the 16th century, Argentina is among the Spanish-speaking countries; with the exception of Brazil (which speaks Portuguese), all Latin American countries are Spanish-speaking [12].
Because Latin American countries do not speak English as an official or mother tongue, students lack the awareness that English allows free access to different people and places and that it is the most studied language in the world [13].
In Mexico, [14], the incorporation of technological resources in the teaching of the English language has been almost nil. In a worldwide ranking of English proficiency, among 72 countries, Mexico is in position 43 [13].
In a similar ranking, among 88 countries, Brazil was ranked 53rd; in 2017 Brazil was in 41st place, but instead of rising positions it fell to 53rd position, in that same

ranking Mexico was in 57th place, Argentina was in 27th place and Costa Rica in 36th place ; Chile ranked 46 [15, 16].
At Costa Rica, material activities for language teaching have focused on music, debates, stimulating images and fun stories, in an attempt to motivate students and immerse themselves in the language [17]
The 27th position makes Argentina the best placed country in English proficiency, among Latin American countries. According to [18] English has become ubiquitous in the daily life of Argentines and it is common to hear from young people that they are learning / training English on their own using digital games, music and other practical activities in English, this may have cooperated for the best English proficiency performance among Latin American countries.

2.3 Use of Educational Digital Games

Many studies and systems have used fun as an aspect to attract students' attention and motivate them, as examples of Educational Games and Gamification of systems [19], so these games must contain elements / characteristics of fun / entertainment. Most educational games do not contain the depth of a rich narrative that can provide engagement as commercial (entertainment) video games do, so educational games should be better developed [20]. Incorporating a rich narrative into an educational environment can support engagement and help improve student / player performance in the educational aspect [21].

The work [22] points out that the vast majority of young Brazilians use video games frequently, but it is usually for entertainment purposes only. This can be used as a motivation for using digital games in education, as many young people are already familiar with the world of digital games, and this is an interesting aspect for the use of this tool in educational assistance. The act of playing / teaching in teaching or learning aims to motivate the student, because it is a hybrid action, in which one learns and has fun, defined as a playful activity, because pleasure is present in the action [23]. There are some problems in developing educational games: developing a good digital game is expensive and time consuming [24, 25], there are very few open-source educational digital games to allow for reuse [26], it is difficult to adapt educational games to contexts distinct in order to adapt them to different disciplines [27], digital games are known to be boring, with rare exceptions, and it is difficult to define in practice what will be fun for a player, [28].

2.4 Open Digital Games and the Culture of Modding

A Digital Game is an interactive software that makes use of audiovisual resources (drawing, animation, music, script, etc.) for the purpose of entertainment. Open software (free and opensource) is software that the developer has made available the source code / project so that people (third parties) can change it and providing a license that allows this manipulation legally. Thus, an open digital game is a game

available for internal manipulation at the source code level and with a license that allows changes without copyright infringement.

There are some opensource digital games on the market, but in numbers far less expressive than commercial digital games. This is because the development of a digital game is expensive and time consuming and companies want to obtain financial return to cover the invested expenses and still generate profit (necessary to keep the company running). So, for big digital gaming companies, the open source philosophy is not interesting, at least not without another type of model that generates profit elsewhere. The Purpose is the adaptation, modification and redistribution of the game to a new context with the consequence of giving a new purpose to the software, which in practice works as a conversion. In the case of this article, the purpose is used and suggested to convert a digital entertainment game to an educational digital game. An important observation is that the Re-Purpose requires that the 5 characteristics of the Willey [29] model be previously met, otherwise the Re-Purpose is impossible.

The open digital game has already been explained, but to understand the purpose of a digital game, we need to understand the culture of modification of digital games. The culture of game modification is already established (it is a current reality) and the trend is that it will continue to grow [30]. Companies started to encourage this culture that was called Game Modding or MOD [31, 32].

3 METHODOLOGY

3.1 The Proposal: Repurpose of the Digital Game

To modify a digital entertainment game to an educational digital game, we tested four games that have open source and free license to choose the game for modification. We focus on games that are coded in Python, Java or C # and with RPG or 2D Platform styles, as they are two very popular and classic styles. The first was Stolen Crow with Python code and MIT license (https://github.com/justinmeister/The-Stolen-Crown-RPG), the second was Platformer Microgame with C # code and license from Unity Free Extension Asset (https://assetstore.unity.com/packages/templates/platformer-microgame-151055), the third was Simple Platformer (https://github.com/SteveSmith16384/SimplePlatformer) with license from MIT and the fourth JumPY Man (https://github.com/haseeb-heaven/JumPYMan-Game) with Python code and GPL3 license. The game chosen was Unity Engine's Platformer Microgame.

Fig. 3. Web Page, in English, of the Unity Free Game

Fig. 3 shows the page, on the internet, of the game Platfromer Microgame distributed free for modification by Unity Technologies, this page is completely written in English.

The educational content of the game consists of part of programming fundamentals and part of technical English to support programming. Programming content consists of: main data types and variables (int, float, bool, string), arithmetic operations (subtraction, sum, multiplication and division), operations and logical operators (And, Or, false, true, not), relational operations and operators (less, greater, equals) if / else statement, for / while statement.

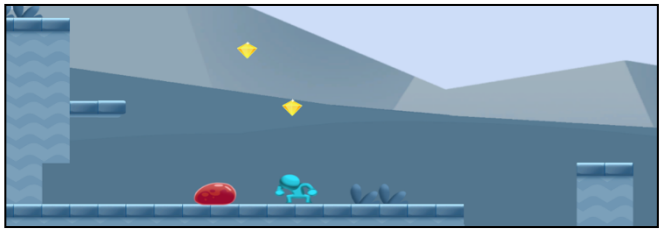

Fig. 4. Original Platform Microgame, free game by Unity Technologies.

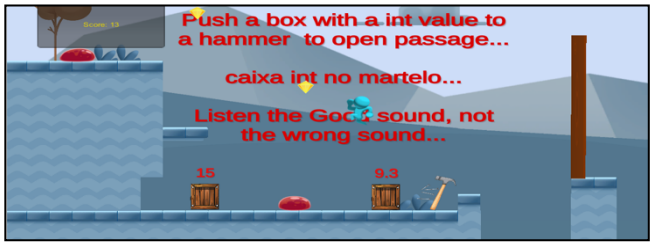

Fig. 5. Modding of Platform Microgame, free game.

Table 1 specifies the details of the game modifications. It is possible to identify in Table 1 how much each game's artifact has been modified for the possibility of the educational purpose of the game.

Table 1. Details and Quantification Of Changes To The Opensource Game

Artifacts	Little	Medium	Much
Programming			X
Art		X	
Scenario			X
Music and Sounds	X		
Narrative		X	
Level Design		X	
Mechanism	X		
Educational Content			X

As can be seen in Table 1, the most modified artifacts were: Programming (C # Script), Scenario (as already shown in Fig. 5) and Educational Content (which was created from scratch and had the narrative as support). Art, Narrative and Level Design were changed less intensely, so that Art and Level Design had a supportive relationship to the modification of the Scenario (and vice versa) and the Narrative served as a justification and explanation of the content educational inserted (so that this content would not be aggressive, too much and would not harm fun and engagement). Mechanics, Music and Sounds were slightly changed. The mechanics were little changed, because the main idea was to make the most of it, because it is a Classic Mechanics and known for its fun and success in several commercial digital games. The music itself has not been altered, but sounds have been added to make the puzzles and their solutions clearer, and these sounds were related to the music to keep the sound aesthetics pleasing.

3.2 Evaluation of the Proposed Digital Educational Game

To evaluate the Read All C # game, an intervention was carried out with 42 higher education students from the Computer Science course. As the objective was to evaluate the students' experience under a qualitative approach, we analyzed two different reference models for the evaluation process. The first was the generic ITU BT500 assessment (https://www.itu.int/rec/R-REC-BT.500) - and the other was the MEEGA + model [33]. After analyzing these two evaluation models, we opted for the second, the MEEGA + model; this model directly supports the evaluation of educational games instead of the generic approach of the ITU BT 500 (for all types of software and not with an educational focus). The main part of the questionnaire applied to students contained the following 14 questions:

1- At the beginning of your programming learning, did you find it difficult to learn programming with the commands in English?
2 - Do you think that a game like this to teach / train technical English focused on programming, can help a beginner programmer?
3- Did you find this game useful for a programming student?
4- The organization of the content helped me to be confident that I would learn from this game.
5- The game does not become monotonous in its tasks.
6- I would recommend this game to others.
7- There was something interesting in the game that captured my attention.
8- I feel satisfied with the topics I learned in the game.
9- The game content is relevant to my interest.
10- It is clear to me how the game is related to educational content.
11- Is the game a suitable teaching method for teaching / training technical English for programming?
12- I prefer to learn from this game than any other way (a technical English book, for example).
13- Does the game contribute to my learning about technical English content for programming?
14- The game was efficient for my learning compared to other activities on this subject.

4 Results

On question 1, 21.4% (9 students) totally disagree; 28.6% (12 students) disagree; 16.7% (7 students) responded neutrally; 26.2% (11 students) agree and 7.1% (3 students) fully agree. On question 2, 0% totally disagree; 2.4% (1 student) disagree; 11.9% (5 students) responded neutrally; 35.7% (15 students) agree and 50% (21 students) fully agree. On question 3, 4.8% (2 students) totally disagree; 4.8% (2 students) disagree; 9.5% (4 students) responded neutrally; 42.9% (18 students) agree and 38.1% (16 students) fully agree. On question 4, 0% (2 students) totally disagree; 2.4% (1 students) disagree; 9.5% (4 students) responded neutrally; 42.9% (18 students) agree and 38.1% (16 students) fully agree. On question 5, 4.8% (2 students) totally disagree; 11.9% (5 students) disagree; 31% (13 students) responded neutrally; 38.1% (16 students) agree and 14.3% (6 students) fully agree. On question 6, 2.4% (1 student) totally disagree; 2.4% (1 student) disagree; 19% (8 students) responded neutrally; 45.2% (19 students) agree and 31% (13 students) fully agree. About question 7, 2.4% (1 student) totally disagree; 0% disagree; 19% (8 students) responded neutrally; 42.9% (18 students) agree and 35.7% (15 students) fully agree.
On question 8, 0% totally disagree; 4.8% disagree (2 students); 14.3% (6 students) responded neutrally; 47.6% (20 students) agree and 33.3% (14 students) fully agree. On question 9, 2.4% (1 student) totally disagree; 0% disagree; 11.9% (5 students) responded neutrally; 54.8% (23 students) agree and 31% (13 students) fully agree. On question 10, 0% totally disagree; 0% disagree; 4.8% (2 students) responded neutrally; 38.1% (16 students) agree and 57.1% (24 students) fully agree. On question 11, 0% totally disagree; 0% disagree; 19% (8 students) responded neutrally; 45.2% (19 students) agree and 35.7% (15 students) fully agree. On question 12, 7.1% (3 students) totally disagree; 7.1% (3 students disagree); 33.3% (14 students) responded neutrally; 14.3% (6 students) agree and 38.1% (16 students) fully agree. On question 13, 0% totally disagree; 7.1% disagree (3 students); 16.7% (7 students) responded neutrally; 14.3% (6 students) agree and 38.1% (16 students) fully agree. About question 14, 4.8% totally disagree (2 students); 2.4% disagree (1 student); 21.4% (9 students) responded neutrally; 38.1% (16 students) agree and 33.3% (14 students) fully agree.

5 Conclusions

Based on the intervention carried out with the questionnaire, we realized that students liked the idea of learning technical English focused on the fundamentals of programming using a digital 2D platform game. It was realized that a game like this can keep students motivated to learn, mainly by answering questions 7 and 9.
The game can make students more interested in the topics of the programming discipline and give more value to the use of the English language for the programming context, since the player is faced with an English vocabulary and expressions to which he must understand to solve the game puzzles that involve programming, as could be seen by the means of questions 2, 11, 12 and 13.

Question 6 resulted in an average of 4 and attests that students strongly recommend this game to other students of programming / technical English.
We realized that the attempt to modify an open-source game was positive and that the educational purpose was achieved; the extension of the 5R model of the open source criteria is possible to include the purpose. This game / MOD can be adapted to other contexts that include other disciplines and students' age groups. What was most changed in the project were the artifacts: programming, setting and educational content; the least altered artifacts were music / sounds and game mechanics, as shown in Table 1.

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