The role of computer programming as a partner in the English classroom

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Abstract: This work reports on some preliminary results of an ongoing study that aims to assess to what extent computational programming can serve as partner in teaching and learning English as a second language. For that purpose, two groups of students from two Portuguese primary schools were studied during the school year 2015/2016. One group completed several sessions of computer programming with Scratch while the other had traditional English classes. Several written and oral tests were conducted to assess students' academic performance and the results were compared. The students' tests scores showed that computer programming had a positive influence in the development of students' writing and reading skills.

1 Introduction

Information and Communication Technologies (ICT) entered into every field of everyday life, shaping the profile of today's as diverse areas as entertainment, communication, economy, health, research and education (Armoni, 2013; Pessoa, 2014). It is plausible to believe that new generations will require a renewed range of skills that includes, among others, fluency in Programming Languages (PL) (Europe, 2015). But the gap between what school teaches and the twenty-first century social demands is noticeable (Wing, 2006).

Several countries, aware of the mentioned misalignment, have updated their curricula to include particular PL, whose teaching at national level is already a reality in most European countries (European Commission, 2015a, 2015b). Besides the enrichment of the digital literacy, there is more evidence that PL – by stimulating the decomposition of complex activities into smaller and simpler ones, recurring to information representation and exploring other concepts, such as abstraction and algorithmic logic (all in all what we call "computational thinking") – foster superior analytical skills, making the early learning of other skills (reading, writing, arithmetic, etc.) easier (Wing, 2006, Resnik et al., 2009; I.S.F.T.E., 2015). This belief justifies the early and increasingly frequent adoption of PL in the different education systems. In this context, the UK stands out, by integrating PL in its curricula from five to sixteen years of age since 2014 (Wilson, 2012; European School Network, 2015).

Despite the inexistence of a systematic survey to support it, it can be said that in Portugal, similarly to what is happening in Europe and in the rest of the world, we are witnessing the growing number of primary and secondary schools where, by local initiative, teaching has been supported by computational thinking (Wing, 2006). It's in this context of enhancement of what Papert advocates since the 60s (Papert, 1980), that the Portuguese Ministry of Education and Science opened the school year 2015/2016 to the introduction of Programming Languages in a pilot project for about 300 primary schools (Ministério da Educação, 2015).

In this work we present the preliminary results of an ongoing project that aims to assess the impact that Scratch – nowadays the most successful educational PL, presented in Section II – might have in the teaching and learning of the English language at its first level as compulsory second language. The objective of this study is to compare the outcome of 3rd grade primary school students subjected to the use of Scratch in the English lessons (Test group) and ones that had no interaction with Scratch programming (Control group), in terms of their satisfaction and receptivity to the learning of English language and linguistic acquisitions within the Common European Framework of Reference for Languages. In brief, this research intends to answer the following questions: Is computer programming beneficial for improving students' English skills? Can computer programming increase students' satisfaction in learning this language?

To address these questions, an initial satisfaction questionnaire and further written and oral tests were conducted, so that both the satisfaction results and test scores of Test and Control groups could be compared. Our findings suggest that computer programming benefits reading and writing skills in particular, as explained in detail in Section IV. Besides the primary schools where the study is already being implemented – Externato de S. Domingos -

Centro de Estudos de Fátima, Portugal as Test group and Centro Escolar Beato Nuno, Fátima, Portugal, as Control group – the University of Coimbra and the Engineering Institute of Coimbra (ISEC) are engaged in both training the teachers and assessing the results of the project throughout the two following school years.

The remainder of this paper is structured as follows: Section II presents a brief background on the use of Scratch programming language as a tool for knowledge construction. Section III describes the methodological steps used in this project: Satisfaction Questionnaires, Placement Test, English Classes and Progress Assessment. Section IV reports the achieved results and finally, Section V presents the conclusions and topics for further work.

2 Background: Scratch as an educational tool

To support the training of computational thinking, several platforms emerged in the past decade and a half, mainly directed at the public whose mastery of the written language was effective, through which interactive applications, animations and games could be built (Buddies, 2015). These tools, of a remarkably constructionist nature, allow an easier engagement and motivation, providing both the students and educators with an intuitive developmental environment in which it is possible to create a myriad of projects only limited by creativity and, therefore, malleable to the different areas of knowledge (Torres & Irala, 2007).

By the number of registered users (over fifteen million) and the number of shared projects (over eighteen million), Scratch, created by Mitchel Resnick at MIT in 2003, stands out (Kindergarten, 2016). This tool is supported by a website devoted to the dissemination, discussion and sharing of related projects, which might be an extra motivation for their users by giving visibility to their individual work (Scratch, 2015). More recently, the Scratch website started offering the possibility of developing the projects online, sparing the programmers of installing any specific software and thus avoiding the consequent undesirable adjustments of operating systems (Resnik et al., 2009). In Portugal, the number of initiatives and scientific studies on the use of Scratch in formal educational environment at the level of the primary/elementary school is still low, although it seems that in recent years it has gained expression (Wing, 2006). One of the great features of Scratch is that students are able to take over, try different things, learn from their mistakes, which is truly the basis of constructionist learning (Fesakis & Serafeim, 2009). By encouraging the creation of small multimedia applications, games, little stories that bring characters into life, Scratch teaches much more than computer programming, digital literacy or linguistic contents, for the matter. Scratch also teaches students to think and solve their own problems, abilities that can enhance all curriculum areas, not just English or programming skills.

3 Experimental Setup

During this project, two groups of 3rd grade students (8-10 years old), who had had previous contact with the English language (all studied English since they were 5 years old) were analysed. These students were divided into a Control group (17 students) and a Test group (16 students) with similar characteristics in what concerns their age, gender distribution and academic results. This work reports on the initial results of a two-year project that is still ongoing, and so far the following phases are complete: 1. Initial satisfaction questionnaires; 2. Initial Placement tests; 3. English classes throughout the school year; 4. Four written tests where the listening, reading and writing skills were assessed; 5. Two Oral Production activities to assess the speaking skills.

3.1 Satisfaction Questionnaires

Before starting the English classes, the students filled in an initial questionnaire intended to collect some information on their overview regarding the English language in everyday life, their preferred activities and major difficulties, academic grades, and overall satisfaction and willingness to continue their English studies. These questionnaires were used to obtain interesting conclusions about students' preferences, and generally characterise both Control and Test groups concerning the student profiles they comprise.

Bearing in mind that these students involved in the study live in Fátima, a highly touristic city in Portugal and to focus on the initial intention of the study, which was to assess the impact *Scratch* would have on the students' learning satisfaction and specific language contents acquisition, some of the questions which were part of these questionnaires were related to the students' appreciation for listening to the English language outside the school context, in films,

songs, videogames, stories, in the street, at the restaurant or at the supermarket. Some of the questions were also associated to their appreciation of listening to the target language at school, and then particularly in the English lessons.

3.2 Placement Test

In order to assess students' English skills in all four components (listening, reading, writing and speaking), all students took an initial Placement test designed for the purpose. The placement test is used to make a diagnostic assessment of students' knowledge on general English contents and can be a baseline to determine students' progress during the school year.

3.3 English Classes

Throughout the year, the students had 46 English sessions, in which the Test group had 17 lessons with scratch, some related to the learning of the English language, and several others where the students were first introduced to this coding language. These introductory activities were designed and programmed by ISEC professors, which also trained ICT teachers to work with such ages. Test group students were introduced to scratch with several activities, in which they were presented with different challenges. When their control over the tool allowed them to make their own decisions, they were challenged to start developing some projects for the English lessons. The first English project (1st term) was related to school material: "What's in my schoolbag today" and they were asked to present some materials they had inside their bags and others they didn't have. They were free to choose both the scenario and the main character, and the materials they had inside their schoolbags, so as the ones they didn't have. The second English project (2nd term) focused on the human body: "Getting to know the human body". In this project, students were asked to imagine a scientist's "incredible journey" inside the human body. The main character, the scientist, would discover the different body systems, and explain their components and functions. Both projects had a simple working script, the subject, description and phases of the project were previously defined by the professors. However, in the 3rd term, the students were encouraged to develop their own projects. On the other hand, the control group continued working within the traditional class standards.

3.4 Progress Assessment

During the school year, both groups took four written tests to evaluate their understanding of the contents discussed in the classes (Test 1, Test 2, Test 3 and Test 4). These tests focused on the listening, reading and writing skills, while two Oral Production tests (Oral Production 1 and Oral Production 2) were used to assess the students' speaking skills. The tests were the same for both groups, to allow a proper comparison between the groups' score results.

4. Results

In this section we discuss some results regarding the information collected during the school year 2015/2016. Firstly, we characterise both control and test groups, with reference to the student profiles comprised in each. Then, we briefly present the overall test scores obtained for both groups (Placement Test, Test 1, Test 2, Test 3 and T4) and discuss their outcomes. Finally, we focus on each English skill in particular (listening, reading/writing and speaking) and provide a more detailed inspection on each student's results and their evolution during the school year, to assess the differences between Control and Test groups' educational outcomes.

4.1 Satisfaction Questionnaires - Cluster Characterisation

To perform a detailed description of the existing student profiles within each group (control and test), we have turned to cluster (Bishop, 2006). Cluster analysis allows us to group subjects (students, in this case), according to their similarities (their responses to the motivation questionnaire). Similar students will be included in the same cluster, whereas different students will be spread apart in different clusters. We've used a method called divisive hierarchical clustering for this analysis: in the initial step of this process, all students belong to a single, unique cluster, and at each iteration, two new student clusters are created and the process is recursively repeated until each student is a cluster per se. The results of a hierarchical clustering can be interpreted through the construction of a dendrogram (a

tree graph that illustrates all the produced clusters) that allows us to find patterns (student profiles) somewhat "hidden" among the complete group of students. Figure 1 illustrates one of such solutions (for the test group).

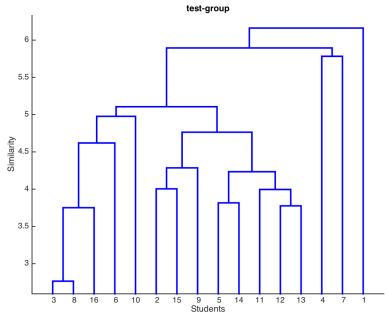

Figure 1: Cluster dendrogram for test group.

The hierarchical clustering procedure revealed the existence of 3 major clusters, both for the test and control groups. Herein, we describe their essential characteristics.

4.1.1 Control-Group Characterisation

Cluster 1 has 5 elements: 2 boys and 3 girls. This is the most motivated group towards English language: all these students like English a lot and appreciate listening to it in movies (60%), games (80%), music (100%) and in the street (40%). All of them like performing activities in the classroom (80% like it a lot and the remaining like it quite much), specially painting (100%), drawing and singing (80%), and reading and playing games (60%), which they also would like to do more often, adding also using the computer (60%). They haven't point out any particular activity they dislike; however some mentioned that copying new words from the board is not their favourite task (20%), and feel some difficulty in reading activities (60%). These students perform all the activities the teacher asks them to and like learning new themes in English a lot, always achieving good grades.
Cluster 2 also includes 5 students: 2 boys and 3 girls. Most of them like English (60% like it a lot, 20% like it quite much), but 20% like it more or less. Generally, they enjoy hearing English in movies (40% like it a lot), games (60% like it a lot), music (40% like it a lot) and in the streets (40% like it a lot). Most of them enjoy performing in-class activities (40% like it a lot, 40% like it quite much) while some just like it "a little bit" (20%). Among their favorite activities there are painting, reading and listening to texts (60%), and they wish they could use the computer (100%), sing and play games (80%), draw and make group activities (60%) more often. Within this cluster of students, 80% perform all the activities the teacher suggests while 20% perform almost all of them. Yet, they all always achieve good grades.

Cluster 3 has 6 elements: 3 boys and 3 girls and it is the least enthusiast group towards the English language. 80% of students like English quite much, but the remaining like it more or less. The percentages of students that like hearing English in movies and games a lot are respectively 30% and 16.7%. As for music and English in the streets, no one has mentioned to like it a lot, but respectively 70% and 50% like it quite much. These students like to use the computer, play games and paint (80%) and copy new words, draw, read and listen to texts (60%). On the contrary, there isn't a consensus on the least preferred activities, although some students don't enjoy singing and make up stories that much. 70% complete all the tasks the teacher requests, while only 16.7% (one student), performs almost all (the reason was not specified), but they all always achieve good grades. As a remark, it's important to mention that on the day the questionnaire was conducted, one student missed the English class and therefore has not filled it. Since the questionnaires are anonymous, this student was removed from the clustering analysis, and that is the reason why the sum of cluster students of Control group only counts up to 5 + 5 + 6 = 16 elements, although this group contains 17 students.

4.1.2 Test-Group Characterisation

Cluster 1 includes 5 students, 3 boys and 2 girls. All of them enjoy listening to English music and most of them also like to listen to English in movies (80%) and games (60%), though not in the streets. It is also not common for these students to listen to stories in English. They are enthusiasts when it comes to performing activities in the classroom, especially painting (100%) and playing games (80%), but not copying new words from the board. They also do not register any difficulties in the great majority of tasks. When asked about which activities they would like

to perform more often, their focus remains on painting and games (60%), adding also group activities (40%) and using the computer (100%). 60% of these students like to learn new themes in the English classes, and 80% perform all the activities the teacher asks (some forget to do all of them). They overall achieve good grades frequently (80%), but only 20% of students always achieve high level grades.

Cluster 2 is composed by 8 students, 4 boys and 4 girls. Their opinions on the English language vary a bit: 50% of them like it a lot, while some don't appreciate it that much (25%), and the remaining truly don't like it. When it comes to English movies, they're not the biggest fans (only 25% enjoy them), but the numbers change in what concerns to music and games (respectively, 90% and 60% enjoy it quite much). Half of them are not used to listen to English stories, but the ones who are don't appreciate it. While in the classroom, some are, yet not all, fond of activities (70%), given that they don't include reading, singing or listening to texts (>75% in all categories). For them, the hardest activities include games, writing stories and some group works. The students in this cluster have also shown a great interest in performing other activities such as drawing (around 40%), painting and games (60%) and using the computer (100%) more often. 75% of students perform all the activities suggested by the teacher, yet some cannot fully accomplish them (without specifying the reasons why). Around 90% of these students achieve good grades, with 40% of them on top of the class (always get high level grades).

Finally, Cluster 3 has 3 students, 2 boys and 1 girl. One likes English a lot, the other two like it not so much. No one particularly likes English movies or music (listening to music and singing is their least preferred activity), neither listen to English language in the streets, though 2 students have shown some interest in listening to the English language in games. Instead, they'd rather copy new words from the board, draw, paint and listen to texts, although they find it difficult to follow some stories. Also, painting, reading, playing games and using the computer are the most desired activities among these students. They don't always perform the tasks required by the teachers, 2 students perform most of tasks and the remaining only performs some (when the teacher insists on doing them) but nevertheless, they usually achieve overall good grades.

Figures 2 and 3 summarise the main profiles of Control and Test groups, respectively. This representation is constructed through the use of Principal Component Analysis (PCA) (De Sa, 2012), where the dimensionality of the data is reduced, allowing a representation of clusters using only 3 dimensions x, y and z axis (three principal components). Originally, each student is represented using several dimensions (features derived from the questionnaires' answers), which does not allow a proper and intuitive visual representation of the found clusters. By reducing the dimensionality through PCA, it's possible to produce a 3D representation of the students' characteristics, enhancing the visual perception of existing clusters. Each student is represented as a point in a 3D space. Similar students lie next to each other and belong to the same cluster, being identified with the same color. A small description of the most common characteristics found within each cluster is presented.

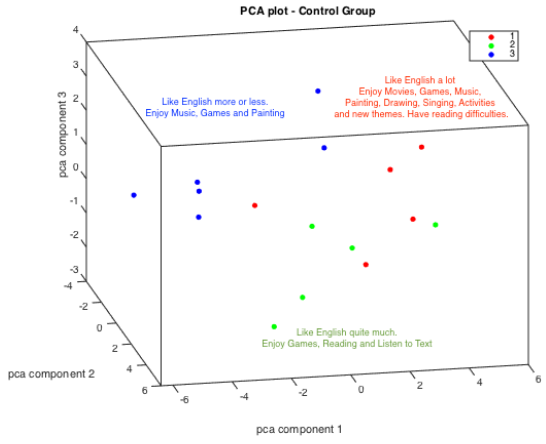

Figure 2: Cluster representation for the Control group.

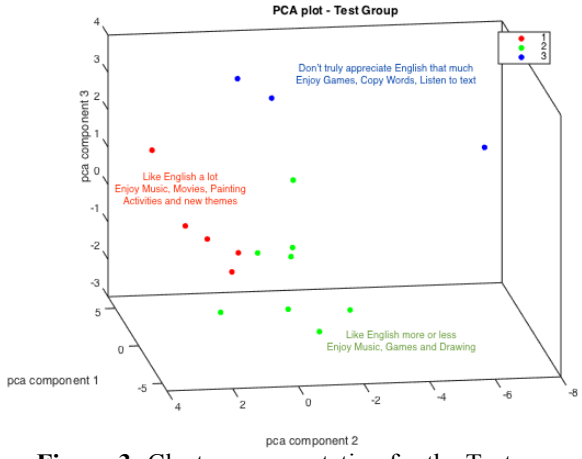

Figure 3: Cluster representation for the Test group.

Comparing both groups it's clear that the Test group is the least motivated to learn English, whereas the Control group seems to be the most "active" and energetic group, where the great majority of students likes to perform more ludic activities (singing, listening to music, painting, drawing, playing games). This group is also more homogeneous than the Test group (the cluster division itself suggests that Test group students are more different

between each other). Moreover, it's interesting to note that all students like games and expressed their desire to use the computer more often during class activities.

4.2 Test Scores

To assess the overall evolution of the students' knowledge, all the students took an initial Placement test before the English lessons, and four posterior written tests during the school year: Tests 1 and 2 during the 1st term, and Test 3 and Test 4 in the 2nd and 3rd terms, respectively. To code the tests' results, a four-point grading was used: 5 (Very Good), 4 (Good), 3 (Sufficient) and 2 (Insufficient), which is the lowest possible grade.

Up until this point, the test scores' results are not totally conclusive; however, there are some interesting aspects to notice (Table 1). Control group obtained higher grades in both the Placement and Test 1, though not in Test 2. In fact, the average grade of students decreased in Test 2, when compared to the average Placement, and that difference becomes clearer when compared to Test 1 scores. The reasons behind this drop cannot be confirmed just yet, although it might be related to the profiles encountered within this group: students that are used to ludic activities in English classes may find it difficult to accomplish certain curricula goals that require them to be more focused and work harder, specially by the end of a term. The average results rise again in Test 3, but another fall is registered in Test 4, showing that, although Control group generally achieves higher results than Test group, their outcomes are not completely consistent.

On the contrary, the improvement of the students in Test group increases overtime, and exceptionally for Test 2, the Test group's results are higher that the Control group's by 0.41 points. Test group reveals a tendency to improve the results overtime, which is noticeable from the increasing improvement from each written test when compared to the Placement test and by the decreasing difference of the average results when compared to the Control group - in Test 4 there is only a difference of 0.18 points, which is significant given the initial difference of 0.57 (Placement test).

	Control Group	Test Group	Difference C-T
Placement	3.76 ± 0.75	3.19 ± 0.83	0.57
Test 1	4.06 ± 0.75	3.44 ± 1.03	0.62
Test 2	3.65 ± 0.93	4.06 ± 1.06	-0.41
Test 3	4.18 ± 1.07	3.81 ± 1.33	0.37
Test 4	4.06 ± 0.9	3.88 ± 1.26	0.18
Improvement P-T1	0.3	0.25	
Improvement P-T2	-0.11	0.87	
Improvement P-T3	0.42	0.62	
Improvement P-T4	0.3	0.69	

Table 1: Test scores by group

Furthermore, the difference found between the standard deviation of both groups (Test group's scores always have a higher deviation) confirms the cluster analysis, where a higher heterogeneity is found among Test group students. This fact led us to briefly inspect the students' scores individually. Figures 4 and 5 show the individual progress of each student concerning the Placement test and Tests 1 to 4. As can be observed, most students in the Control group maintained or improved their grades from the Placement Test to Test 1 (only one student had a lower grade). The same cannot be said relatively to Test 2, where, in general, students had worst grades. However, most students have recovered in Test 3, with nine students obtaining simultaneously their best mark in the whole school year and the best possible mark (5 points), which resulted in a considerable increase in the class average (4.18 points. The improvement of test scores in the Test group is not very evident from the Placement test to Test 1, while as for Test 2 the progress is noticeable: most students maintained or improved their grades (only one student had a lower grade). Most students sustained the results of Test 2 in Tests 3 and 4, despite the slight decrease of two students (level 3 to 2) and a fall of a level 5 student (in Test 2) to level 2. This student, however, had always level 2 grades in the written tests, with Test 2 being an exception.

Although Test group does not achieve better results (in terms of class average) than the Control group, as verified in Table 1, the tendency of the great majority of these students is to improve their grades. With the exception of four students with level 2/3, the remaining students either maintain their good grades (levels 4 and 5) or improve their grades: level 4 students improve to level 5, level 3 students improve to level 4, and in some cases, level 3 students become level 5 students by the end of the school year. Test group contains a more heterogeneous population whose tendency is to improve their grades, while Control group registers a homogeneous population of students, generally achieving better grades, but whose grades are much more fluctuant. Most Test group's students consistently improve

their grades overtime, while Control group contains students that jump between higher and lower levels throughout the year.

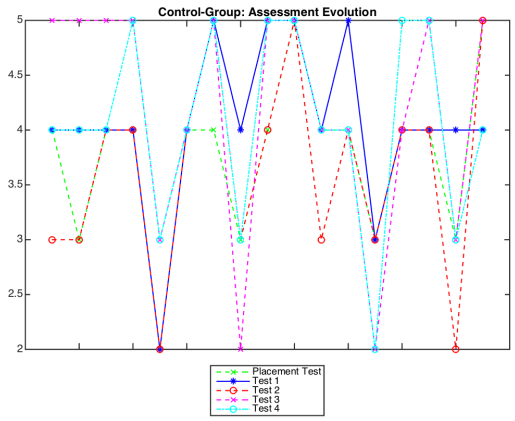

Figure 4: Test scores of control group.

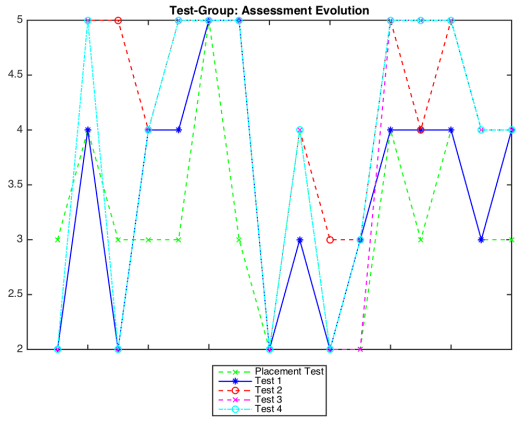

Figure 5: Test scores of test group.

4.3 English skills assessment

The overall test results have not shown clearly significant differences between the groups. Therefore, it was decided to study the differences in improvement of four particular English skills: speaking, listening and reading/writing. These four skills were assessed in the Placement Test initially, and during the school year as well. Test 1 to 4 have specific exercises to measure the listening, reading and writing components, while for the speaking component two Oral Production tests were further conducted. Tables 2 to 4 and Figures 6 to 11 illustrate the progress obtained in each English skill and are further discussed herein.

		Control Group	Test Group	Difference C-T
Speaking	**Placement**	3.65 ± 0.70	3.75 ± 1.18	-0.1
	Oral Production 1	3.82 ± 1.01	3.69 ± 1.14	0.13
	Oral Production 2	4.18 ± 1.01	3.56 ± 1.26	0.62
	Improvement P-P1	0.17	-0.06	
	Improvement P-P2	0.53	-0.19	

Table 2: Speaking Component Assessment

Regarding the students' speaking skills, the initial placement of both groups was very similar (with just a difference of 0.1 points). The first oral production test shows an improvement of the Control group's speaking skills: an increase of 0.17 points in the average grade of the class (Table 2), with five students progressing from level 4 (Good) to 5 (Very Good) (Figure 6). In the second oral production, the Control group was even better, and all students (except for three), improved or maintained their grades (half the class improved their scores). In the Test group, there were no improvements; on the contrary, the class average decreased overtime. However, the global panorama has not changed much: regarding the first oral production, only one student had lower grades than the Placement, and in what concerns the second oral production, three students lowered their grades while one increased from level 3 to 4 (Figure 7).

It's interesting to notice that the Test group seems to surpass the Control group in this skill, with a Placement result 0.32 points higher (Table III). Nevertheless, the Listening results are not very conclusive: Test group registers an accentuated drop in Test 1, while Control group drops from Test 1 to Test 2, and therefore there is no sufficient consistency of results to draw any relevant conclusions. It's important, however, to point out that Control group students have never had an average lower score than the Placement test (Figure 8) except for 1 single student. The same cannot be said for Test Group students, with Test 1 results being worse than the Placement scores for all students, except for 2 of them (Figure 9).

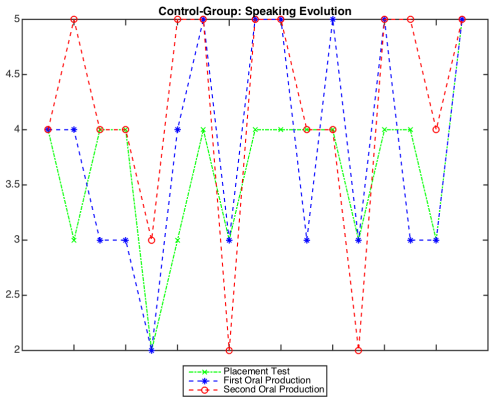

Figure 6: Speaking skills progress for control group.

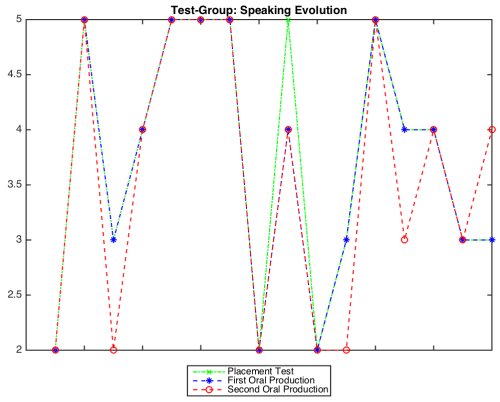

Figure 7: Speaking skills progress for test group.

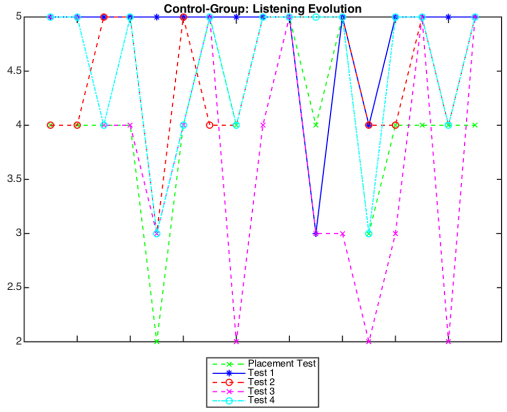

Figure 8: Listening skills progress for control group.

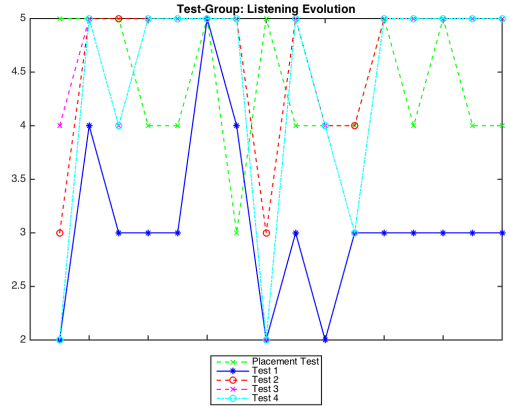

Figure 9: Listening skills progress for test group.

The reading/writing results reflect the same tendency as the global test scores (Table 1), as expected: the reading/writing component represents 70% of the written tests, while only 30% is dedicated to testing the listening skill. Therefore, the results obtained in this English component are very similar to what was described for the global assessment evolution: the students in Control group registered a considerable drop of their grades in Test 2 and fluctuant scores overtime, whereas the Test group students kept showing an increasing improvement throughout the school year.

		Control Group	Test Group	Difference C-T
	Placement	4.06 ± 0.75	4.38 ± 0.62	-0.32
	Test 1	4.82 ± 0.53	3.06 ± 0.77	1.76
	Test 2	4.47 ± 0.62	4.63 ± 0.72	-0.16
	Test 3	3.76 ± 1.15	4.5 ± 0.89	-0.74
Listening	**Test 4**	4.53 ± 0.72	4.38 ± 1.09	0.15
	Improvement P-T1	0.76	-1.32	
	Improvement P-T2	0.41	0.25	
	Improvement P-T3	-0.3	0.12	
	Improvement P-T4	0.47	0	

Table 3: Listening Component Assessment

However, there is a particular aspect worth mentioning in what concerns the difference between the scores of Control and Test groups, when considering all English skills and the reading/writing skill in particular. Considering

all English skills (speaking, reading, writing and listening), there is a difference of 0.57 points between the Control and Test groups (Table 1), while this difference is much more pronounced when the focus is solely on the reading/writing skill (1.27 points) (Table 4). With the exception of Test 2, where Control group had an accentuated drop in the average class results, and also bypassing Test 3, where Control group students were extra motivated to increase their grades given their previous failure, the differences between both groups are considerably smaller when the focus is only on the reading/writing skill. A difference of 0.62 points (Test 1) becomes 0.13 and a difference of 0.18 (Test 4) becomes only 0.07 points (Table 4), which compared with the initial placement (1.27 in this particular skill) is outstanding. This suggests that the major benefits of computational programming were noticed in this component (reading/writing). While the highest improvement of Control group was 0.7 points (Test 3), the Test Group never registered an improvement inferior to 1.31 points (Table 4), which is well represented in Figures 10 and 11.

		Control Group	Test Group	Difference C-T
	Placement	3.65 ± 0.93	2.38 ± 0.89	1.27
	Test 1	3.82 ± 0.73	3.69 ± 1.14	0.13
	Test 2	3.41 ± 1.12	3.88 ± 1.09	-0.47
	Test 3	4.35 ± 0.93	3.69 ± 1.3	0.66
Reading-Writing	**Test 4**	3.88 ± 0.86	3.81 ± 1.28	0.07
	Improvement P-T1	0.17	1.31	
	Improvement P-T2	-0.24	1.5	
	Improvement P-T3	0.7	1.31	
	Improvement P-T4	0.23	1.43	

Table 4: Reading/Writing Component Assessment

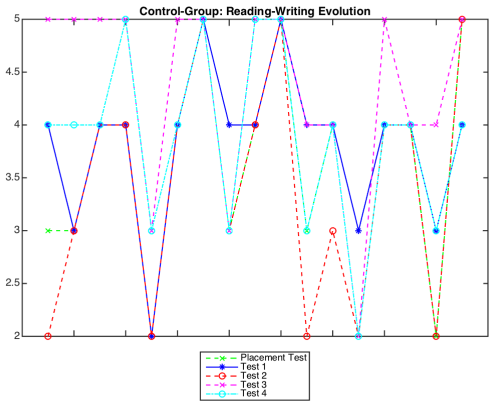

Figure 10: Reading/Writing skills progress for control group

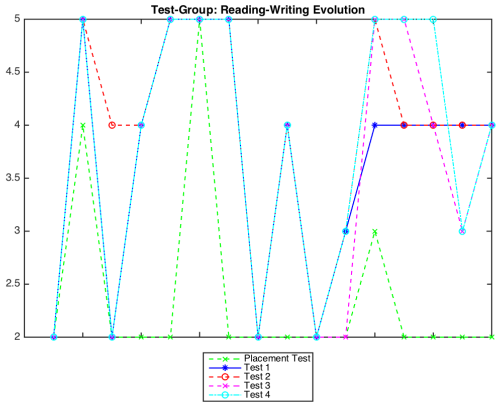

Figure 11: Reading/Writing skills progress for test group.

5 Conclusions and Further Work

In this work, the initial results of an ongoing project that aims to assess the benefits of computer coding (in particular Scratch programming) in the learning of the English language at its first level as a foreign language were presented. At this point, the obtained results are still preliminary, given the number of students and the working time in coding activities. Nevertheless, some interesting conclusions can be drawn: computer programming seems to have a positive impact in the development of English reading/writing skills, which is plausible since the coding activities with Scratch mostly involve dragging the desired commands ("wait, move, play, say") from a menu of events, and therefore students need to make an effort to read the commands (reading skill), and place them in a correct grammatically order, to make sense of the whole intended action ("writing skill"). The listening and speaking skills did not register any relevant improvements.

To determine to what extent coding helps students to develop their English skills, more data is required, so that statistically significant conclusions can be drawn. Future work should increase the number of students, the number of sessions with Scratch programming and evaluation moments, and possibly expand the experimental setup to include

other curriculum areas (Gomes & Mendes, 2006). In this way, it would be possible to determine if students can generalize the computational thinking skills, developed when coding, to other subjects achieving a concrete answer to a more broaden research question: "is computer programming truly a partner or a hindrance in learning? "

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