Computer Programming Workshops with Playful Environments for Middle School Girls

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***Abstract*—This research to practice full paper explores the role of programming workshops for girls of primary education in changing perceptions and interests of this audience regarding joining this field. A programming workshop with the playful environment Scratch and a teaching-learning approach based on challenges was held in a middle school of city in the northeast of Brazil, and was analyzed using a mixed-methods case study. Results point to increased interest in the field after the workshop and no confirmation of erroneous stereotypes about the area. We conclude that this type of workshop is relevant to better understand and potentially improve girls' perceptions about the field of computing.**

I. Introduction

The presence of women in computing dates from the early days of computing. Various women have developed and continue to develop essential work for the advancement of information technology. The literature highlights the importance of mix and match of male and female views in the scientific and professional environment. Female participation offers new looks for the various fields of knowledge [1]. Therefore, it can be argued that the presence of men and women in information technology teams is necessary to provide different points of view to promote innovation [2].

Despite the importance of the participation in the computing world, declining numbers suggest that girls are not seeing computing as a popular career option [3]. Various studies show that boys have greater confidence and interest than girls in the various areas of computing [4]. The point is that society has created barriers ranging from negative stereotyping to lack of support for women in undergraduate computing programs [5]. These barriers end up generating consequences that, in turn, lead to more barriers to the female retention in the field of information technology (IT). The image created by society that computing is a male activity makes few women consider it as a career option. Rarely, parents, friends and classmates encourage girls to follow the study of computing [5]. Women in our society receive less support than men in this field, finding few female colleagues for help. Even college professors may discourage them with unadvised remarks [5].

Researchers seek to understand the reasons for this small number of women in IT and the low interest of women in the field. They also try to contribute with possible solutions to this issue. Cohoon [5] recommends methods to recruit and retain women in computing programs. She highlights, among other methods, the use of female role models of success in the field to recruit high school girls. Misa [6] warns that if we do not change the workplace conditions as well as the image of this field, women can be encouraged to follow a profession that may end up being frustrating. Teague [3] asserts that stereotypes and erroneous perceptions about computing are reasons for the low number of women in the area. She seeks to understand the motivations of female IT professionals that chose the field of computing.

Scaico et al. [7] suggest the use of recreational tools for teaching and learning programming for teenagers with no prior experience as a way to bring pleasant experiences into practice. Positive experiences can help reduce errors in code produced at this early stage, errors that can lead to discouragement of beginners. These same authors also believe that these facilitating learning environments must be accompanied by a teaching-learning approach that keep students excited and motivated to learn. Aureliano and Tedesco [8] assert that Scratch, for instance, is a playful tool that contributes to the development of creativity and problem solving. Ericson and Macklin [9] conclude, in their work, that summer camps offering programming courses are a good way to engage female students and other underrepresented groups. These authors also recommend the use of free playful tools like Scratch or Alice for the computing education of students in elementary, middle and high school.

This work performs an analysis of behaviors and attitudes on computing of female students from a public middle school. We measured the perceptions and interests of these girls before and after taking part in a programming workshop. The workshop was planned to account for the student profile in the age and level of understanding they were. We used a teaching-learning approach based on simple programming challenges through the development of games and animations with the playful tool Scratch. Two workshops were run: a pilot workshop to aid in adequate planning of workshops for middle school girls, and a final workshop, with improvements from learned lessons from the pilot workshop. In the latter, we collected and analyzed both qualitative and quantitative data.

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II. Background

Demographic trends show that the number of women graduating from computer science programs has declined [10]. According to the Brazilian census of research groups in 2002, the proportion of women in the academic field in the areas of engineering and computer science was around 30% [11]. This proportion is not very different in undergraduate courses around the world. Data collected in about thirty countries on the female presence in computing programs show that the proportion of women in this branch varies between 10% and 40% in most countries [12]. In Brazil, an analysis from the National Household Sample Survey (PNAD) of 2009 points out that the percentage of women in the science and technology professions who worked as professionals and technicians was, respectively, 18.5% and 11% [13].

A. Factors that may lead to low female representation in the computing field

In many countries, the structure and culture of computing professions discourage a significant number of women from studying or working in the field [6]. Various reasons lead to female disinterest in this environment [3]. Some of them include the different ways boys and girls learn, career stereotypes, experiences at school and less girls' experience with computers when compared to boys. Gürer et al. [14] also mention some additional reasons. Among them, the fact that girls are more timid in their use of computers than boys, who are more extroverted and have a greater spirit of exploration. Another reason pointed out by the authors is the lack of female self-confidence, which leads them to leave the area or even prevents them from entering it. Barker et al. [15] cite the female portrait produced by the media as one of the explanations. For them, images of men and women in the media carry implied and meaningful messages. They also address the fact that there are few female role models, which leads to lack of inspiration for girls.

Girls usually have more negative attitudes towards computers, and are portrayed as having less self-confidence than boys [16]. The stereotypes existing in families, social groups and the media are also contributing factors to a mannish view of computing. In addition, girls' lack of self-confidence may prevent them from engaging in the field.

Scragg et al. [17], in their study of both male and female students in introductory courses in computer science, have noted that women generally have a slight feeling that their contributions are devalued in class. That happens even though there is no evidence that they feel discriminated in the opportunities of contribution. They also infer from the results of their research that female self-confidence and male dominance in the IT environment may explain the low retention of women in the field.

B. Projects carried out for the recruitment of girls for computing

Understanding what attracts women to computing helps in planning recruitment strategies [10]. A qualitative research involving 18 university departments in the United States gathers a number of reasons why female computing students chose this field [5]. This research further suggests that interventions by universities with activities and specific programs can be very effective, sometimes eliminating male stereotypes associated with computing.

In the same vein, other forms of attraction of girls to the field are being continuously explored. The Girls on the GO: The Mobile Computing College Experience project, carried out at the University of Miami, teaches programming for high school girls, seeking to encourage women's interest in computer science in a variety of ways. In addition to showing how flexible the work in computing is, the activities of this project seek to exercise creativity. The focus is on designing a mobile application that can be used by researchers to document and study animal behavior [18].

Another project seeks to develop a computing curriculum for high school girls based on constructionism, where students learn best by creating something tangible [19]. Seeking to increase the self-confidence and interest of girls in the area, the authors of this paper developed and tested a four-week computing course for high school students. In this course, they used *PicoCrickets* kits, which combine basic programming concepts, electronic devices and design.

Kelleher et al. created a storytelling-focused programming environment, Storytelling Alice, to tackle low female representativeness in the field and motivate high school girls to learn programming [20]. They compared it against the generic Alice in a workshop for girls. Results showed that both environments are effective to teach programming, but the participants who used Storytelling Alice had greater motivation to code.

To adapt programming teaching models, course materials were developed based on the constructionist philosophy and applied in a course for both high school boys and girls [21]. Materials had instructions for each activity, and were only displayed when the teacher felt its need. Results pointed to the internalization of certain concepts and an improvement in cognitive performance. However, students showed problems with the abstract concepts such as variables and concurrency.

Other authors used a visual environment, collaborative learning and creativity fostering to develop two workshops focused on improving the understanding of mixed-gender students from different schools on computing and their perceptions about the field [22]. Results showed that collaborative work significantly accelerated learning, and that a visual environment such as Scratch aids in introductory CS learning.

In Brazil, some projects have been carried out with the same goal of fostering female interest in the field of computing. The project Digital Girls conducts lectures, visits and other initiatives in Brazil [23]. Authors report a pilot experiment in a public school in Cuiabá, with activities in the area of human-computer interaction with nine teenage students, aiming to contribute to the dissemination of computing with this public. The project addresses the design of interfaces from unplugged computing activities. Also in the area of human-computer interaction, a short course was held for high school girls at

a public school in Guarapuava, Paraná [2]. The short course used concepts of semiotic engineering and aimed to present a computing space to teenagers that dealt with more than the technological aspect alone.

Using the aforementioned papers and the literature as a basis, this paper describes a programming workshop geared towards girls, similar to Girls on the Go [18] and various others. We created an environment adapted to the local reality, and designed a workshop focused on the profiles of girls from our city's schools and their age group. From a pilot project, we also adapted activities, games and animations to their tastes. This quest for a better setting may also be seen in Storytelling Alice [20]. We also used challenges to instigate problem solving and creativity, using the ideas of constructionism in Scratch [24]. With this design, results not only captured better student perceptions of the field, but also collected data that adds to the literature and that may serve as a basis for workshops in other cities and countries.

III. Methodology

First, we describe the programming environment used, *Sratch*, and then, the actual planning of the workshops.

A. Scratch

Scratch is an environment developed in the MIT *Media Lab*. It has a block-based programming language inspired by the languages *Logo* and *Squeak*. To achieve its goals of introducing programming for children and adolescents, Scratch has the following design principles: being more tinkerable, more meaningful and more social [25]. To be more tinkerable, Scratch uses a block-based language similar to the existing blocks in Lego toys. To be more meaningful, it allows you to create a variety of projects (e.g., games, animations, simulations, representations) and import and create a variety of media. To be more social, it allows projects to be shared and remixed through a social network.

Scratch allows users to create projects that control graphics, animations, text and audio, and can interact with external objects. The programming is done through scripts made by the insertion of command blocks, which are grouped in the following themes: motion, looks, sound, pen, control, sensors, operators and variables. This makes it simple to create games and animations. The manipulation of the blocks is intuitive and performed through direct manipulation with mouse and keyboard. Scratch's social network allows users to share and reuse other projects made and shared by people around the world, offering inspiration, support and interaction to users of the environment.

B. Planning

The proposed programming workshop was adapted from the previous experience of other workshops carried out by our computing education group at the State University of Feira de Santana (UEFS) [26], [27]. Since 2012, our group has offered programming workshops in schools in the city of Feira de Santana, Brazil. Before this experience, a pilot experiment was carried out with girls from the sixth grade of the Assis Chateaubriand Integrated Education Center, a state school of basic education [28]. Workshop content and organization was tested and better adapted to the workshop experience described in this paper.

The aim of the workshop was to develop students' notions of algorithms and programming, to be able to create small applications, from animations to games, using the Scratch environment. The teaching and learning approach of both workshops consisted in the proposal of a set of challenges that were given to students so that they could gradually develop an application. Thus, creativity and the investigative spirit of these girls would be instigated at all times. These ideas of playful and creative learning are based on the constructionism of Seymour Papert [29], in which students build their own knowledge, and are reiterated by Resnick [30], who defends the idea of the learning process as a spiral. In this spiral, in turn, the cycle begins when learners imagine what they want to do, then a project is created based on their ideas, and this project is tested and shared with other learners. Reflection on the lived experiences would then lead to new ideas to be developed.

To carry out the workshop at the school, we first publicized the workshop with girls in different middle school classes at the school, inviting voluntaries to take part in it. Since the girls who have registered were minors, we asked their parents to authorize their participation in the workshops and to sign a free and informed consent term to allow their participation in the research. All parents agreed with their daughters' participation both in the workshop and in the research. The workshop was held at the Gastão Guimarães Institute of Education, and a total of 12 middle school, female students aged from 12 to 16 enrolled in the workshop. A group of assistants and observers were recruited to support the activities. Activities had a workload of 12 hours and were split into 4 weekly meetings of 3 hours each Tables I and II show, respectively, an overview and a detailed planning for the execution of the workshops.

The proposed animations and games considered the likes of girls in this age group, elicited through a *brainstorming* with the students participating in our research and extension group, as well as adapted after observing the students' feedback to the games used in the pilot workshop. The first activity was an animation with the cat character of Scratch. The other two activities were classic games, simplified for the duration of the workshop sessions and the age group. *Pacman* was adapted to a *Pacwoman* in order to guarantee the identity of the participants with the games.

C. Data Collection and Analysis of the Workshop

Questionnaires were distributed and answered on the first and last day of workshop. They addressed issues such as the affinity of the girls with the computer, questions related to their impressions about the workshop, and the facilities and difficulties faced during the workshops. Observations were also made during the sessions, considering both individual

Table I
WORKSHOP OVERVIEW

Programming Workshop with Playful Environments for Girls	
Goals	To be able to develop small applications and games in the Scratch environment, flexibly expressing herself through the computer.
Approach	Learning through discovery of Scratch environment, guided by challenges proposed by a tutor in the form of animations and games aimed at girls.
Content	Scripts in Scratch. Sensors and looks. Select and repeat structures. Variables, logical and arithmetic expressions. Logical and relational operators. Communication between objects.
Tutor, Assistants and Observers	Four students from a Computer Engineering undergraduate program.
Place	Laboratory of Informatics of the Gastão Guimarães Institute of Education.
Participants	Middle school students from the seventh grade of a state public school.
Period	4 weeks.
Workload	12 hours, split into 4 sessions of 3 hours.
Classes	1 class with 12 students.

and group behavior of each participant. The observations also addressed aspects such as the productivity of the girls and their adaptation to the Scratch tool, the presented programming concepts and the approach based on challenges.

For the analysis of relevant aspects of the observations, the data collected were coded through content analysis. Content analysis is a set of techniques that uses systematic and objective description procedures. These techniques include steps like the coding of results, categorizations and inferences. In this work, coding, including categorizations and inferences, was performed using a tool for organization and analysis of qualitative research content.

To analyze the answers of the applied questionnaires, responses were initially tabulated in Google Forms/Sheets. Then, questions were grouped by common themes, average response values were computed, and graphs were generated presenting the central tendencies of these grouped questions. Comparative charts of similar questions were created from the pre- and post-workshop questionnaires in order to observe possible student opinion changes after attending the workshop.

IV. RESULTS

Here we present the results from the final workshop, both from qualitative and quantitative data.

A. Qualitative Analysis

Lab sessions were supported by four students from a computer engineering program, members of our computing education group. One of these students took on the role of class tutor. Another student took the role of assistant. And the remaining two assumed the position of observers.

The sessions were guided by "challenges", with the development of three projects: an animation with the Scratch kitten creating dialogues, the PacWoman game, and the Space Invaders game. Basically, at the beginning of each project, we showed a possible final result of each game or animation to be developed. Then we asked participants to perform simple tasks in order to reach the final result. With each new concept needed for the development of the activities, a brief explanation was made, bringing forth new challenges. To make activities more enjoyable, we encouraged students to create their own scenarios and objects for each project.

1) Difficulties Presented by Participants in the Use of Logic and Tool: Various participants had difficulty handling Scratch. Some of them even had problems with drawing objects on the screen, and asked for help. Difficulties in programming logic were very frequent. A basic difficulty shown by some participants in the first session was how to keep the cat continuously moving on the screen. Some participants had trouble creating the dialogues, and forgot to add delays between sentences. The sentences then appeared all at the same time. One of the biggest difficulties was in the development of the Space Invaders game. Participants were able to put objects on the screen and even have the bullet leave the ships, but when a bullet hit an alien, neither the alien nor the bullet did disappear. In this case, they needed to create a slightly more complex algorithm, using a condition for collision detection and, then, the *hide* command. Many other references to difficulties with logic were detected in the observations, such as using the command *if on edge, bounce* to detect a collision with the maze of the PacWoman game, difficulties to implement scores using variables, implementing the end of the game, among others.

2) Positive Impacts and Participant Responses: During the sessions, in general participants performed the proposed activities and showed a strong interest in completing them, asking what the next activity was. Some of them sometimes stayed in the lab during the break or returned early, continuing the development of the projects.

The sessions brought positive aspects such as interaction among participants and even participants helping each other. We noticed that various girls exchanged ideas and sought to guide their classmates when they were able to advance in a challenge that others had not yet been able to. Sessions became even more entertaining as they watched one another's projects and even laughed at the drawings and bugs of their classmates.

The proposed activities, especially exploration (when we left the girls free to navigate the tool and play with the objects on the screen), were also quite entertaining for the participants. Making objects move, spin, and change effects made the girls relax, giggle, and interact with each other by showing their achievements. We also noticed that participants were enthusiastic. They showed satisfaction and excitement in

Table II
DETAILED WORKSHOP PLANNING

Class	Activity	Goals	Content
1st Day	Animation with the Cat – Adaptation of the cat character of Scratch for a female version.	This session intends to present the Scratch environment, making students able to navigate the tool and search what they need.	Inserting objects. Changing scenarios. Moving objects. Objects costumes. Introduction to select and repeat structures. Communication between objects.
2nd Day	*PacWoman* Game: An adaptation of the *Pac-Man* game where the character eats berries in a maze – Part 1	This session aims to enable students to develop part of a relatively complex game using the basics of programming and slightly introducing the use of variables.	Select and repeat structures. Sensor reading. Logical and relational operators. Introduction to Variables.
3rd Day	*PacWoman* Game – Part 2	In this session, students continue to apply the basics of programming, plus learn to use variables to count.	Select and repeat structures. Sensor reading. Logical and relational operators. Variables.
4th Day	*Space Invaders* Game: Adaptation of the classic game where a ship defends its base from alien attacks.	This last session aims to make girls able to develop a complex game by applying and deepening the programming concepts already learned.	Strengthening of all concepts learned in previous classes.

meeting some past challenge, and sought to make the drawings in the best possible way. One of the participants filmed the animation she was able to do, and another still showed interest in installing Scratch at home. We also observed that the activities that most stimulated girls' creativity were linked to the creation of stories and the drawings of the objects in the projects. Some girls designed more complex PacWoman labyrinths and others designed simpler ones.

3) Discouragement and multitasking: Behaviors divergent with the workshop goals were frequently observed. They insisted on using the internet during sessions, accessing Facebook or even playing other games. Some participants were using the mobile phone both during project development and during explanations of new concepts. In addition, many participants were restless and some groups had parallel conversations raising excitement in class.

B. Quantitative Analysis

For the final workshop, we made the questionnaires simpler when compared to the pilot workshop, better adapting them to the profile of middle school students. We changed the question format, questionnaire size and language used, and we used only three levels in the Likert scale. Qualitative values in the Likert scale were converted to a scale between one and three in the analysis. We kept the same groups of questions used in the pilot questionnaires. However, we improved the connection between the groups of questions in the pre- and post-workshop questionnaires. A total of 12 participants answered the pre-workshop questionnaire and 10 participants answered the post-workshop questionnaire. The average age of the students was 13 years and all of them were in the seventh grade.

1) Possible Influences for the Choice of Engineering and Computing Fields: This group of questions sought to investigate the existence of possible role models for girls in the field of computing. We also analyzed the influences from her friends' views on the fields of engineering and computing and the incentive from their parents to engage in these fields.

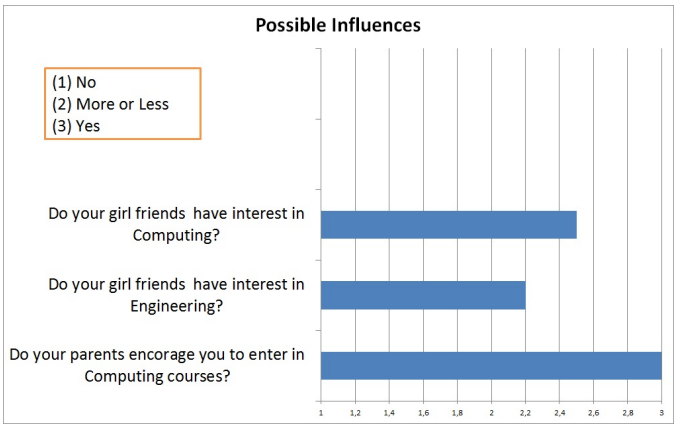

Figure 1. Presence of influences to engage in engineering and computing

Analyzing the student answers, we notice that 58% of these girls know a woman who works in the field of computing. However, there is less influence of the family as role models for these girls (33%).

Figure 1, reveals that possible influences from their friends are from neutral to positive. Graph averages show that most of them have friends who, in general, sympathize or at least do not dislike the fields of engineering and computing. Moreover, we note that students' parents unanimously encourage their daughters to take computing courses.

2) Career Intentions and Perceptions about Engineering and Computing: This group of questions analyzes participants' career intentions and perceptions on the fields of engineering and computing before and after attending the workshop. It also analyzes their perceptions about stereotypes associated with the computing profession. Finally, it investigates possible changes of understanding of these fields after the workshop.

Figure 2 provide comparisons of students' career perspectives before and after attending the workshop. We observe a

slight decrease in students' interest about engineering careers and a large increase in interest in computing careers. It is worth mentioning that those students may have not thought thoroughly about career choices yet.

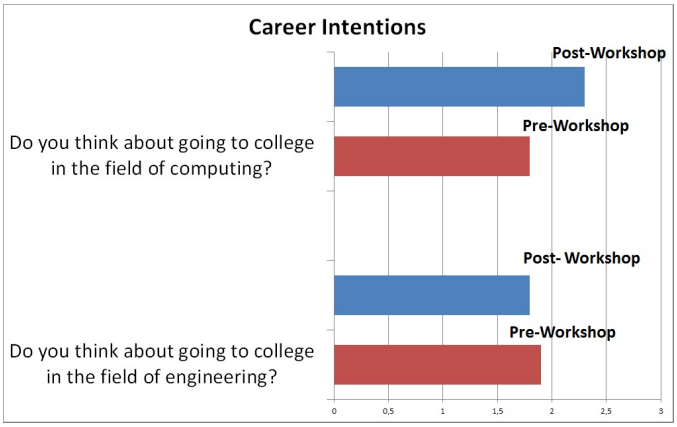

Figure 2. Career intentions before and after the workshop

Figure 3 analyzes stereotypes and attitudes about computing, programming and games. We observe that both before and after the workshop, students do not support, in their great majority, those stereotypical views.

Regarding girls' perceptions of computing, Figure 3 still shows that, after the workshop, there was a slight increase in the opinion that computing is hard, although it is not a significant increase since the average remains below neutral. Strangely, there has also been a slight decrease in the average of responses on whether engineering is hard.

There was a relative interest increase in the field of computing, above neutral after the workshop. There was an interest decrease in the field of engineering, below neutral after the workshop. A strength of the workshop is on the notion of what programming is. In Figure 3, we notice a significant increase in the average of answers to the question *Do you know what programmers do?*.

3) Impressions About the Tool and the Ease of Using Scratch: This group of questions seeks to analyze participants' impressions about the Scratch tool. Knowing that Scratch is a playful environment developed to make programming fun and easy for children and adolescents, we seek to collect students' perceptions about the potential of this tool to stimulate creativity and to make programming simple and easy.

Figure 4 shows that Scratch actually fulfills the role of a playful tool for learning programming. Participants, for the most part, rated the tool as easy to use, easy to understand, and stimulating creativity.

In Figure 5, we notice that participants had an easy time using the tool, with no big difficulties in the different command blocks. The block of variables proved to be the hardest. This result, although positive, is not consistent with the observations made in class. There, we noticed that participants showed difficulties to develop the projects.Some of them often seemed discouraged for not being able to finish the proposed activities. Sometimes they had to wait for the tutor or assistant to aid in solving their issues.

4) Impressions About the Workshop: The questions in this group seek to assess the goals of this work as well as to aid in planning new workshops. It shows participants' perspectives about the workshop as a whole, in terms of organization, fun, ease of learning, among other aspects. In addition, we try to uncover students' interest to participate in new workshops and to continue learning programming.

Figure 6 reveals a favorable view of the workshops. Students unanimously found the classes organized, fun and with good teaching, facilitating their learning. However, in spite of a positive number of responses, we noticed that the sessions were not so light and we also need to improve context exposure.

Answers in Figure 7 show that there are girls who intend to participate in a new workshop and to learn more about computing. These data are positive regarding the attraction of girls to the field of computing and the dissemination of computing among them.

V. Discussion

The workshop had positive impacts on students' impressions and interests, challenging them and giving them the opportunity to develop games and animations. Participants also presented difficulties during project development. In spite of this, it was possible to awaken in those girls a new look at the computing field, seen as potentially fun, challenging, sociable and creative.

The use of a playful tool like Scratch had a positive impact in arousing participants' interest in the activities and in having fun. Participants were enthusiastic in the sessions, had fun using the tool, especially when they were left free to explore it. We noticed that the projects carried out stimulated students' creativity in creating stories and objects for each game and animation. In fact, in the questionnaires, participants scored Scratch as a tool that stimulated their creativity, and this was confirmed in our observations.

We observed that participants were already interested in computing and did not carry a stereotyped view of this field. This reveals a more optimistic scenario compared to some authors, such as Abbis [16] and Teague [3], that assert that gender and career stereotypes are factors that lead to low female representation in computing. After the workshops, the participants presented a relative increase of positive impressions about the field. In addition, participants presented significant changes in their perceptions and interests on the field. They unanimously asserted an interest in learning more about computing, and presented a relative increase in intentions of majoring in the area of computing. For perceptions such as these, it is important to hold workshops of this type, clarifying what programmers do and what computing is, in order to arouse greater interest in the field. In fact, offering short courses can be a way of attracting people to the field of computing, as pointed out by Ericson and Mcklin [9].

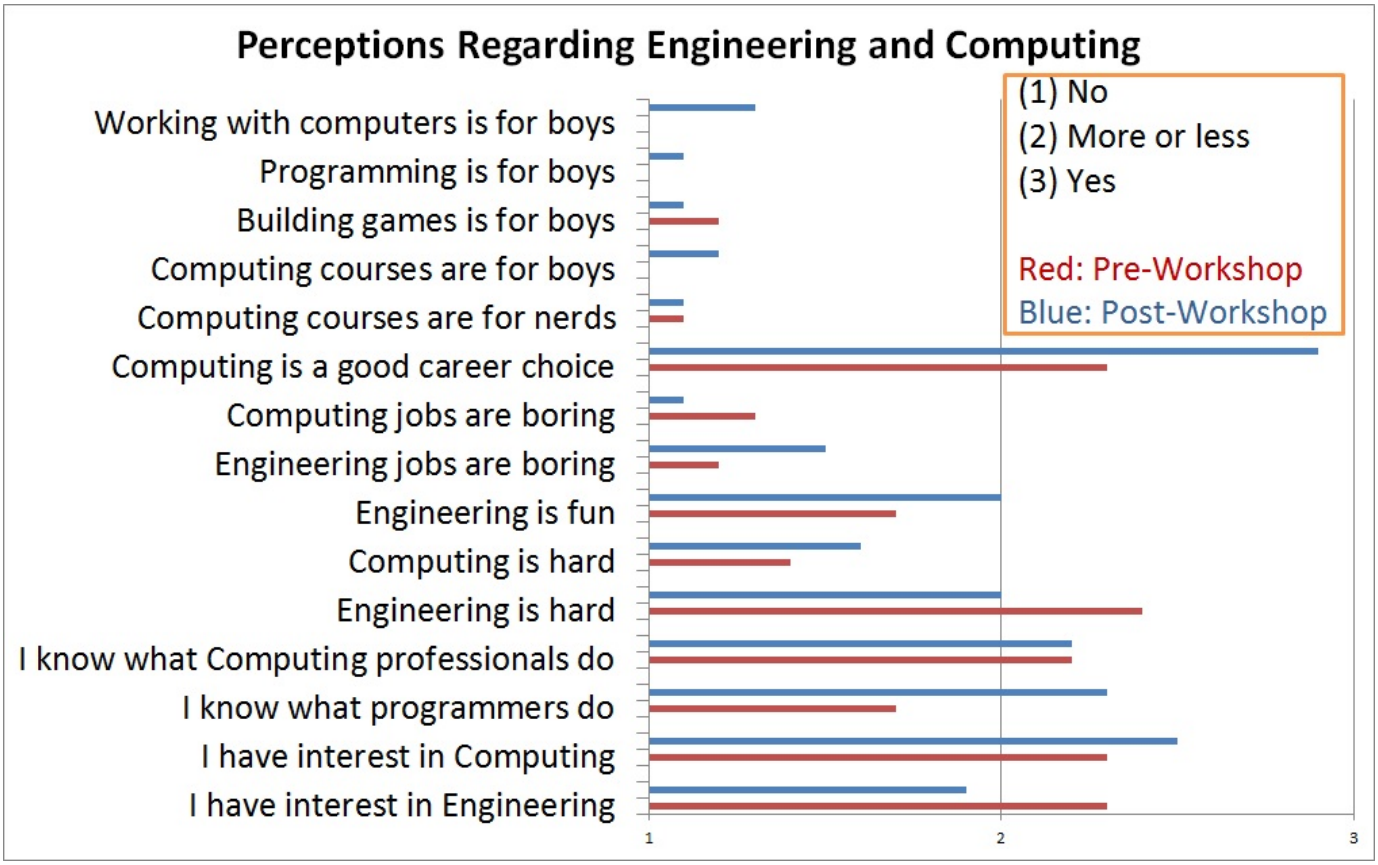

Figure 3. Perceptions about the engineering and computing before and after the workshops

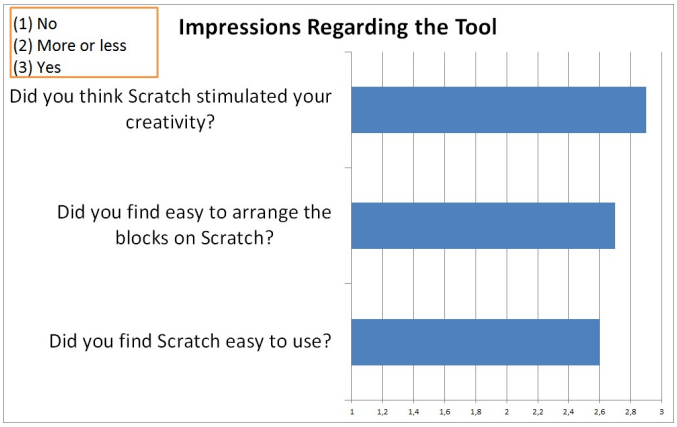

Figure 4. Participants' impressions on the Scratch environment

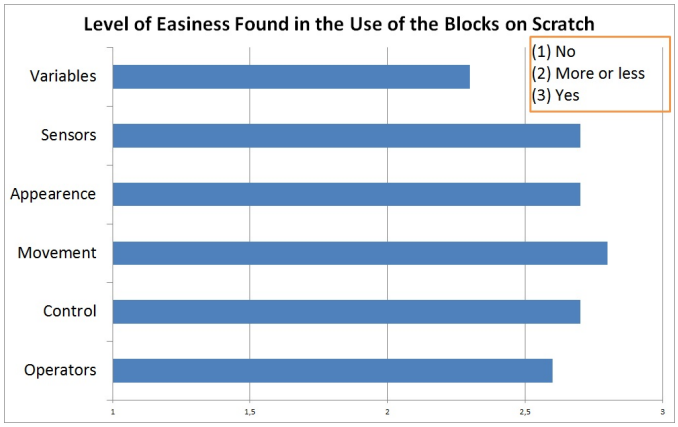

Figure 5. Participants' views on the ease of use of Scratch blocks

Regarding the influences exerted on participants' interests, in general, we can infer that the environment where these girls are living, whether their school environment, home or friends, does not negatively influence their choices and perceptions about the area of computing. Even though, for most of them, there is not a marked presence of family members working in the field of computing, their friends have a reasonable interest in the field. Various of these girls also know of a female professional who works in computing.

We noticed that the difficulties related to the use of the tool and to the development of logical reasoning were common during the workshop. In fact, used to the style of traditional classes in schools, the proposal of challenges may lead to deadlocks among participants. The observations reported that they showed difficulties both in the use of the tool and in the use of the command blocks. They also needed a lot of assistance from the tutor, even though they scored Scratch with medium difficulty to use, and almost no difficulty to

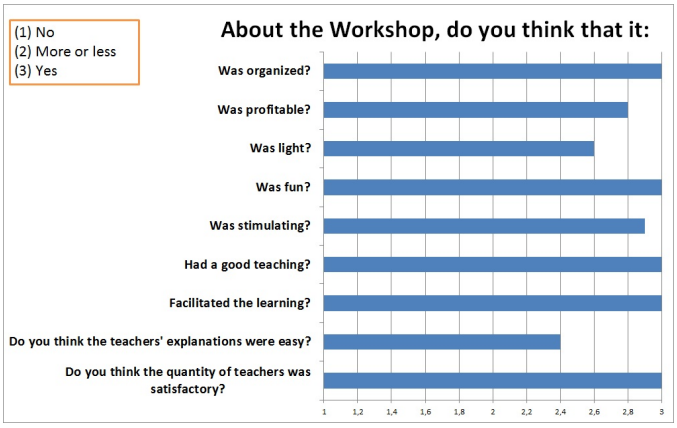

Figure 6. Participants' impressions about the workshop

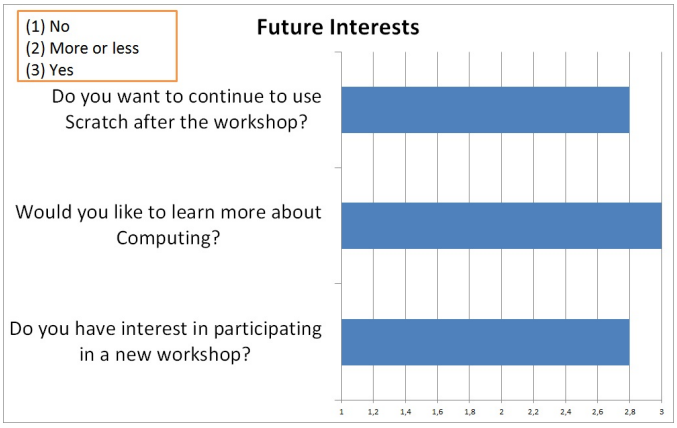

Figure 7. Participants' interest in new activities

use the command blocks. Despite that, we noticed adequate student mastering of the command blocks at the end of the workshops. Some with better mastering, others with less, which is natural in learning environments, especially in a relatively short period. For a better understanding of the concepts, one would need to continue the classes to reinforce and deepen the knowledge acquired.

The challenge-based learning model, while inducing students to think and develop logical reasoning, may have not been so well accepted, and it should be carefully planned before application. Not all participants have a great investigative spirit. While trying to solve a problem and failing to do so, no matter how much the tutor or assistant provide tips and support, they tend to be discouraged and give up, migrating to other activities such as playing on the computer or talking to friends. This scenario confirms the position of Scaico et al. [7] that assert that learning environments should be accompanied by appropriate teaching-learning methods, keeping students motivated.

The use of games was positive and stimulating. This reinforces the results obtained by Carmichael [10], who, in a course for girls, also had good acceptance of the use of games. Participants, in general, responded well to the use of games as projects to be developed.

As one of the workshop goals, we wanted to stimulate participants' creativity in the search for solutions to the challenges proposed. However, we noticed that creativity took place, for the most part, in creating stories and objects for the games and animations. We hoped that, when confronted with a playful tool, creative thinking would be instigated in the construction of solutions. However, participants, when facing bigger problems, felt discouraged and jusy waited for tutor help. Despite that, it was possible to observe the presence of some students who stood out for their greater resourcefulness and creativity in project development.

VI. Conclusions

This work carried out an analysis on the perceptions and interests about the field of computing of middle school girls from a public school in Feira de Santana, Brazil, before and after attending a programming workshop using the Scratch playful environment. We describe the results obtained from in-class observations as well as from pre- and post-workshop surveys. Finally, we discuss the results obtained and lessons learned.

Results showed issues encountered during the workshops and participants' behaviors during the sessions. Participants were excited and encouraged by the projects to be developed, and at the same time dispersed when faced with problems that they could not solve. We also report the frequent difficulties showed by participants in the use of the tool and in developing the projects. Then we report participants' self-evaluations of their difficulties. In addition, we perceive the absence of stereotypes associated with computing in participants' views, given the good influences and incentives exerted by either female role models in the field, family or friends. We also compare participants' impressions and interests of the field of computing before and after attending the workshop, generally maintaining a positive view or improving it.

Students liked the activities performed, demonstrating excitement and creativity in the development of the projects. That suggests that it is possible to offer workshops that reveal computing as a fun, sociable and challenging field. The teaching-learning approach based on challenges induces the use of logical reasoning for problem solving, but it should be better adapted to students' profiles at this age. Some participants often felt discouraged and dispersed when they could not solve a problem. On the other hand, the use of games made workshops fun and facilitated student learning.

In future work, we intend to deepen the analysis with similar workshops in other school environments. We also intend to conduct a longitudinal analysis of the evolution over time of girls' perceptions regarding the field of computing. Another approach to be explored is offering workshops with both boys and girls and an analysis of the interactions between boys and girls when the universe of workshop participants is mixed. Another interesting research track is the analysis of informal situations of learning programming with girls, inside programming clubs.

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