V. Course Results

This section presents the course results from two perspectives: qualitative and quantitative. We applied perception surveys and graded the concept checks to somehow evaluate these two perspectives, respectively. The outcomes are presented below.

A. Perception Surveys

The objective of the surveys was to understand how the student's perception about programming changed from the beginning to the end of the course. Two surveys were designed to measure the student's perception, one that was planned for students to take on the first day of the course and the second for students to take on the day before the graduation. The surveys were constructed based on previous questions and sections of questions found in the state of the arts, as well as questions that we found pertinent to the specific context.

The first survey we revised came from a study that wanted to explore why are women not studying STEM degrees [11], we included questions regarding the perception students have towards the concept of programming, such as if they have thought about studying a carrier related to technology or programming and why.

A second survey that was revised was part of a study that tried to understand the differences that study courses and gender inflict in confidence, attitude, student numbers and motivation in computer science [12]. Based on this survey, we included questions related to the self-perception students have of themselves towards programming, such as if they believe the can learn to program and if they believe programming is going to be valuable for their futures. Also, we asked the students to write terms they relate to programming, to understand what the perceptions are towards this concept. Finally, we included questions related to the motivation students have received to study carriers related to technology or programming and from whom does this motivation comes from.

The third survey we revised was from a study investigating differences in the views of girls and boys members of a computer science club [13]. From this study we found pertinent to ask questions related to the students' perception towards programming and computer science and what their future study and work plans look like, to understand the different interest they have. We came out with a survey including the following sections:

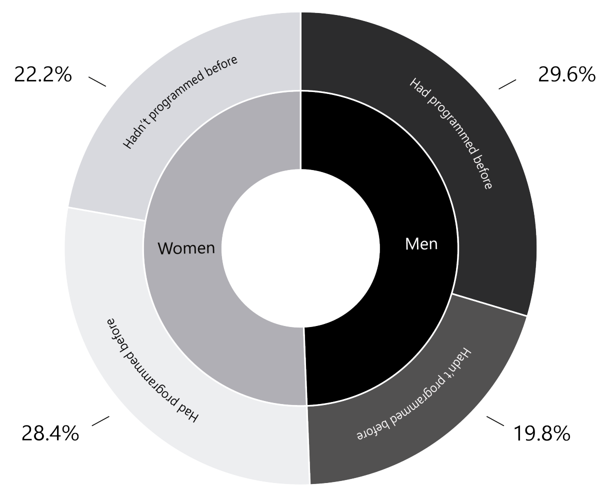
- Demographics
- Background students had in programming
- Self-perception of students towards programming in both surveys to understand how it changed after taking the course
- Perception of the concept of programming in both surveys to understand how it changed after taking the course
- Questions regarding the experience in the course

Section 1 was needed to correlate answers with gender, school, and background. Sections 2 and 3 were inspired from the aforementioned studies [11]–[13], but we also added questions that we wanted to explore such as for which professionals is it important to know how to program. Finally, Section 4 questioned about the course experience in overall.

The surveys given to the students can be found in the annex. Next we present the results of the surveys completed by 82 of the students attending the course. Several visualizations were created to understand the qualitative aspects of the course.

1) Demographics: Figure 1 shows the distribution of the students that attended the course based on gender and if they have had previous experience programming. We can observe that there was an almost equal attendance in terms of gender in the course. Also, we can observe that 58 % of the students already have had a first approach to programming, which was not expected due to the fact that the programming course does not require any previous knowledge besides being able to turn a computer. Figure 2 shows the languages students knew before the course to understand what the previous knowledge was.

Fig. 1. Demographics



We can observe that the language of programming that most students knew before the course was C++. Also, 13 students have had previous knowledge with Python, the language that was taught in the course. Another relevant piece of information is the fact that there was little previous knowledge regarding block-based programming.

These results suggest that half of attending schools are putting efforts on training students in programming, regardless of the language of training.

2) Motivation: Figure 3 shows the motivation students have received to study a carrier related to programming or technology. The graphs are divided by gender, and they show the percentage of motivation that comes from family members, teachers, friends, acquaintances and others. We can see that the main motivation that students have in general comes from their

Fig. 2. Programming Languages previously known by students

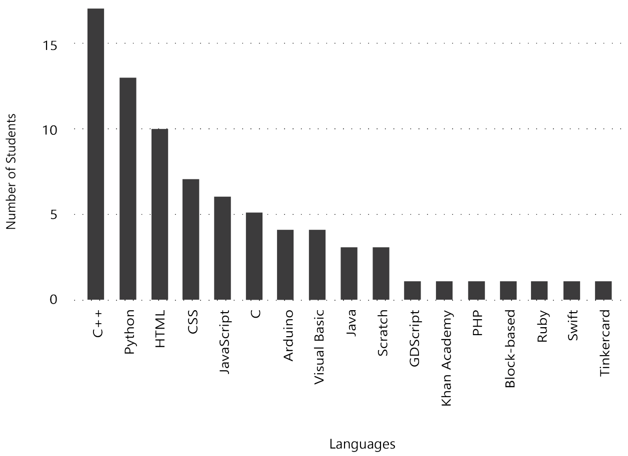
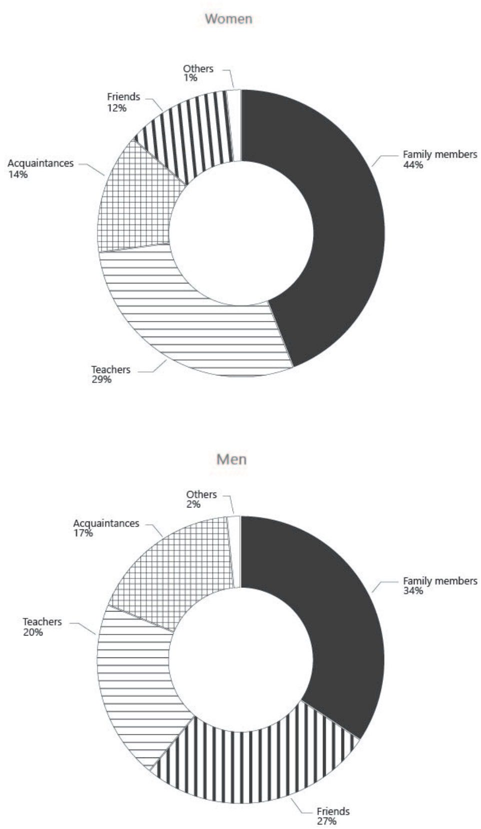


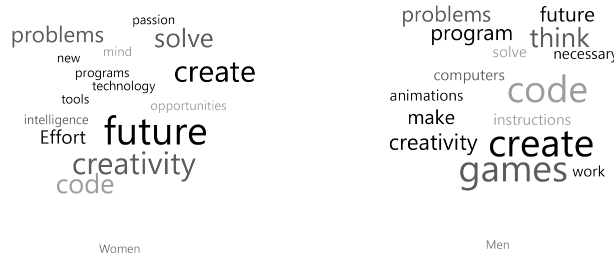
Fig. 3. Source of motivation students receive by gender



families. The second source of motivations varies between women and men. It can be noted that in men there is a greater motivation on the part of their peers, such as their friends. Meanwhile, we can see that women are more motivated by authority figures such as teachers and acquaintances.

3) Terms associated to "Programming" after the course: The students were asked in the survey to write which terms

Fig. 4. Terms by gender

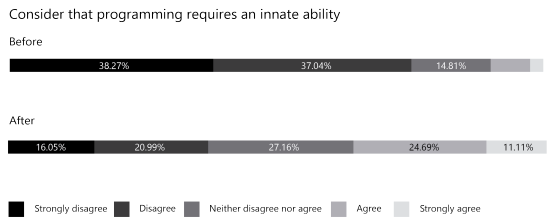


they relate with the concept "programming" after taking the course. The results are visualized in figure 4 by gender to determine differences between the perception of girls and boys. One of the terms that is present in both genders is "Code" which makes sense due to the practical approach of the course in which the students had to code every single day. "Creativity" is also a word that is present in both genders, although it is bigger in women. This probably has to do with the fact that one of the last lectures before the survey was called "Creativity in engineering". Another relevant aspect is that "Future" is a term that is present in women but not in men. Also, "Games" is a term that is very relevant in men, but not in women. This term of games probably has to do with the fact that in the final project, which had an open brief, almost all the students decided to make videogames, as they had in mind the final exercise of creating the game "breakout". The aspect that men associate the word game more than women do probably has to do with the fact that culturally videogames are a product made by men for men. Lastly, it is important to note that the term "Effort" is more relevant to women than "Intelligence". This visualization might indicate that the attending women could perceive that programming has a strong component of effort involved and it is seen as a discipline where an innate natural intelligence is needed, which has been reported in several literature as a fact that discourage women from studying STEM disciplines.

To further investigate this matter, we asked students to answer how much innate natural intelligence they thought was needed to code in the beginning of the course and at the end. Figure 5 shows that before the course, the majority of the students strongly disagreed or disagreed, which was the desired response. We discriminated this by gender and women's response was even more negative, 82.9 % strongly disagreed or disagreed vs the aggregated result (both genders) that was 75.3 %. But, after the course, the students' opinion shifted and we can observe that it is more divided, and some students started to agree or strongly agree, in both genders.

4) CSBridge Experience: Figure 6 shows the overall perception students had of the experience in the course. The average score was 4.7 out of 5. Also, most of the students (97.53%) had a "good" or "very good" experience, which is

Fig. 5. Perception of innate intelligence



a very positive result.

Fig. 6. CSBridge Experience

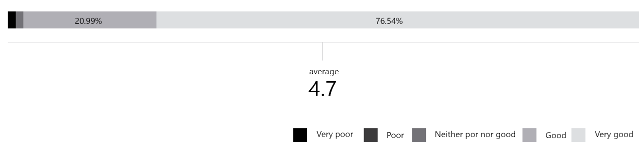
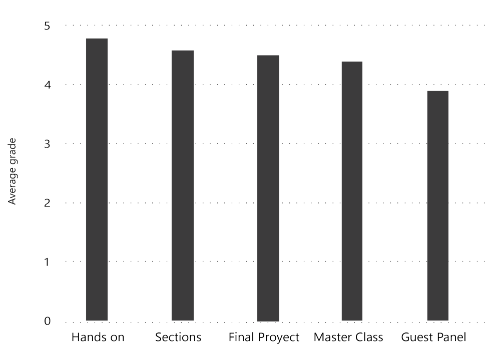


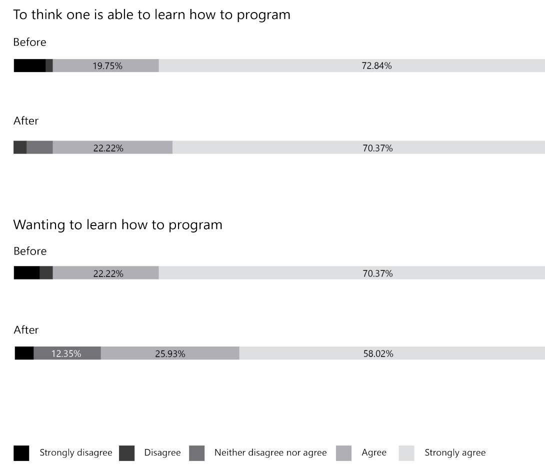
Figure 7 shows the average grade (from 1 to 5) students gave to each of the elements of the course, based on the contribution to their learning process. We can see that the activities that students thought were more helpful were the practical ones, Hands on and Sections. The Guest Panel and the Master Class (lectures) were the elements that students thought were less helpful, probably because they were the less dynamic and interactive activities. The final project was assigned in the middle. The project, although it was a practical activity, wasleft to the last two days of the course and students demonstrate stress feelings about the challenges that it brought.

Fig. 7. Average grade for each element of the course



5) Self perception: In figure 8, we can observe how the self perception of students changed from the beginning of the course to the end. The self perception was measured in two aspects, the first one is if the students consider themselves capable of learning how to program. The second one is if the students want to learn how to program. Students were asked to answer if they Strongly agree, Agree, Neither agree nor disagree, Agree, or Strongly agree. We can observe that in both cases, the students that were over confident with their abilities to program and answered 'Strongly Agree' in the first survey, were reduced in the second survey, which shows that they understood the effort needed to program. By the other hand, we can observe that in both cases the students that 'Strongly Disagreed' in the first survey were also reduced in the second one, showing that those who thought they could not program at all changed their mind in the course.

Fig. 8. Self perception of students before and after the course



We also discriminated this data by gender and we could observe that although the perception of women and men before the camp was very similar, after the camp the positive self-perception of women was less than men in both wanting to learn how to program and thinking one is able to program.

B. Concept checks grading

We asked section leaders to grade the work that students submitted to each concept check. The purpose was not to evaluate students to decide if they passed or not the course, instead we would to investigate if there is significant difference when comparing the performance of women and men. To this end, each concept check was graded in one of the following performance levels:

1) 5 (Perfect Implementation): meaning that the submitted code executes as expected.
2) 3.5 – 4.9 (Functional implementation with small problems): examples of small implementation problems are: functions results are not assigned to variables to be used in the principal program, when calling a function the parameters order is changed, etc.
3) 0.1 – 3.4 (Implementation with serious problems): meaning that the submitted program does not run.
4) 0 : no work was submitted to the concept check.

1) Grade ranges: Every section of figure 9 represents a different percentage of submissions that were graded in line with the aforementioned performance levels. 58% of concept

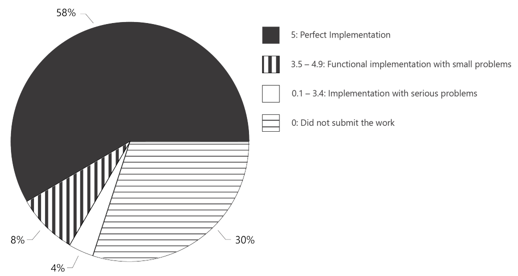


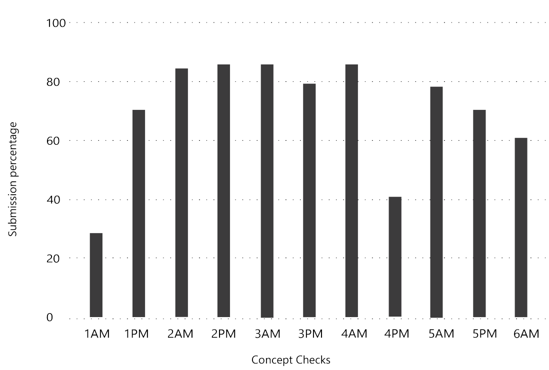
Fig. 9. Submission percentages per concept check

1AM	Setup
1PM	Karel
2AM	Karel
2PM	Karel
3AM	Variables, Control Flow
3PM	Functions
4AM	Graphics
4PM	Revisiting concepts. (optional)
5AM	Animations
5PM	Lists
6AM	Mouse

TABLE I
TOPIC BY EACH AM/PM JOURNEY

checks were graded with a five (5), 8% were graded in the range of 3.5 and 4.9, 4% were graded in the range of 0.1 and 3.4, and 30% were graded with a zero (0). Most of the analyzed values fell within either zero (0) or five (5). This implies a tendency towards the extremes of our grading system.We tried to correlate these values as dictated by three factors: gender, school of precedence of the students, and previous knowledge. Regarding gender, there were no significant differences between the performance of male and female students. With respect to school of origin, we found inconclusive results given the variability in the number of students sent from the education institutions (between 3 and 13 subjects). Finally, regarding previous knowledge, it was not possible to study correlation due to the lack of student identifiers in the surveys records needed to match qualitative data with the grades extracted from the learning management system.

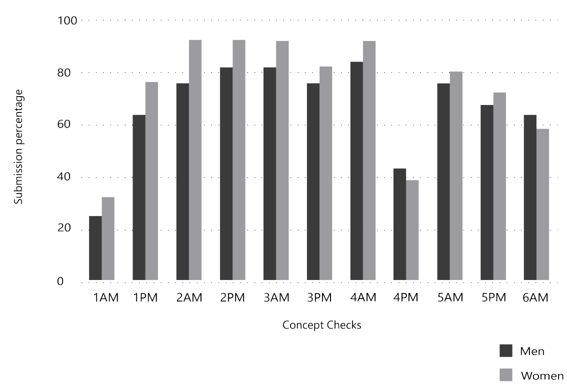
Fig. 10. Submission percentages per concept check



2) Submission percentages: In figure 10 we observe the submission percentages per concept check assigned to students, in chronologically order, starting from 1st day up to 6nd day. In most days, students had a check in the morning session (AM) and a check in the evening session (PM), right after the lectures. The last check was in the morning of the 6nd day since after that students focused on the final project. Every concept check aimed at evaluating the performance of students on one or more subjects, addressed during the lectures, as indicated in the following table:

There are a few tendencies to be noted in figure 10, mainly the decline in submissions during the second week, starting by the evening session of the 5nd day (referred as to 5PM in the graph). This decline can be explained by the introduction of the project to students which made the submission of concept checks of a lesser importance for them. Also it is worth noting the low rates of submission during the sessions of 1AM and 4PM. 1AM is explained from the fairly unconventional circumstances of the first half of the first day where most time was spent setting up programming workspaces and getting the students integrated as a group. As for 4PM, it was mostly a session to revisit previous concepts and finish previously unfinished work, and as a result, most students were more concerned on catching up on work.

Fig. 11. Submission percentages per concept check, discriminating data by gender.



Finally, figure 11 displays percentages of submission per day/session, but discriminated by gender. It is worth noting that female students had a slightly higher submission rate than their male counterparts. This does not mean a higher performance of female students when compared to that of males. Instead, one can interpret that female were more committed to submit their work to the learning management system.