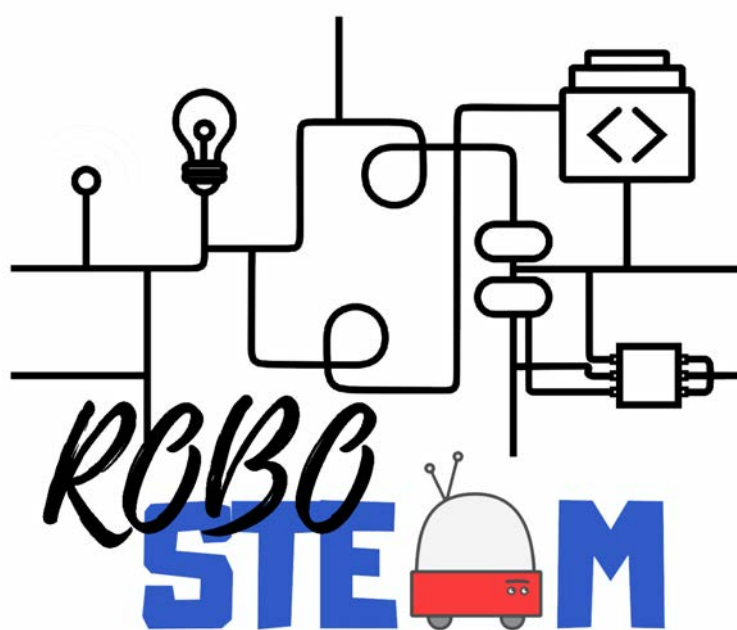

O2.COVID-19_2 - Validation of the adapted tools for COVID-19 times



Version	1.2.1
Date of issue	29/05/2021
Filename	ROBOSTEAM_O2COVID-19_2_29052021.pdf
DOI	10.5281/zenodo.4841159
Nature	Report
Dissemination level	PP (restricted to other programme participants)

Version History

Version	Date	Comments
1.0	31/10/2020	Testing instrument
1.1	30/11/2021	Inclusion of Hackaton Evaluation Results
1.2	31/01/2021	Inclusion of C6 Results
1.2.1	29/05/2021	Errata correction

Table of contents

1. O2.COVID-19_2 – Validation of the adapted tools for COVID times.....	4
2. The process and tools applied.....	4
2.1. Hackathon.....	4
2.2. C6 Virtual Exchange.....	7
3. Evaluation Results.....	9
3.1. Hackathon.....	9
3.2. C6 Virtual Exchange.....	10
4. ACKNOWLEDGEMENTS.....	24
5. REFERENCES.....	24

1. O2.COVID-19_2 – Validation of the adapted tools for COVID times

This document describes the work of the RoboSTEAM project [1-8] Output 2 – COVID-19_2 included because of 2019 pandemic situation and the impact in the project [9-19]. The output aims to validate the tools selected and implemented/adapted during O3.COVID-19_1 [20]. In the project management handbook, the output is described as follows:

“Test the tools during Hackaton and C6. The schools of the partnership tested the tools during C6 and help to report problems that should be addressed and improve them to be applied in the specific pandemic context”.

In this task the schools and the universities assess the tools adapted because of the COVID-19, this testing is carried out in the daily work of the pilots¹ and 2 stages, but more specifically in a dissemination event as the hackathon and C6.

2. The process and tools applied

As commented in the Project Management Handbook COVID-19 [21] pandemic situation has an important impact in the project because it has associated a delay in many tasks, but because it implies also to work in other directions, that takes into account the project main aim but also how to overcome the difficulties risen by the global health alert. One of them was the definition of tools to facilitate the completion of the pilots and also the simulation of robotics challenges in virtual environments. This has been described in O3.COVID-19_1 [20] and it is necessary not only to include them as a possible tool as was done in O3.A4 final report, but to test them in real contexts such as the hackaton with stakeholders of the educational context and during C6, a virtual exchange that includes all the schools and the support of all the universities involved in the partnership.

2.1. Hackathon

The first testing context is the Hackathon that took place the 3rd of November of 2020 at the Instituto Politécnico de Bragança it involves a competitive event in which the participants, will develop nanochallenges based on physical devices and simulation, that are were used in challenge-based learning [22, 23] activities during the

RoboSTEAM Project. The Hackaton was intended for students and researchers, and it is a multiplier event that had as goal to share some of the Intellectual Outputs of RoboSTEAM. One of the used was **a simulated robot, prototyped to compete in the micromouse competition, using a hardware in the loop approach**. To minimize the gap between the simulation and the real implementation, a Hardware-in-the-loop technique was proposed allowing to control a simulated Arduino based robot with real hardware. It involves 38 person and was very successful. In Figure 1 it is possible to see some of the participants testing the simulators.

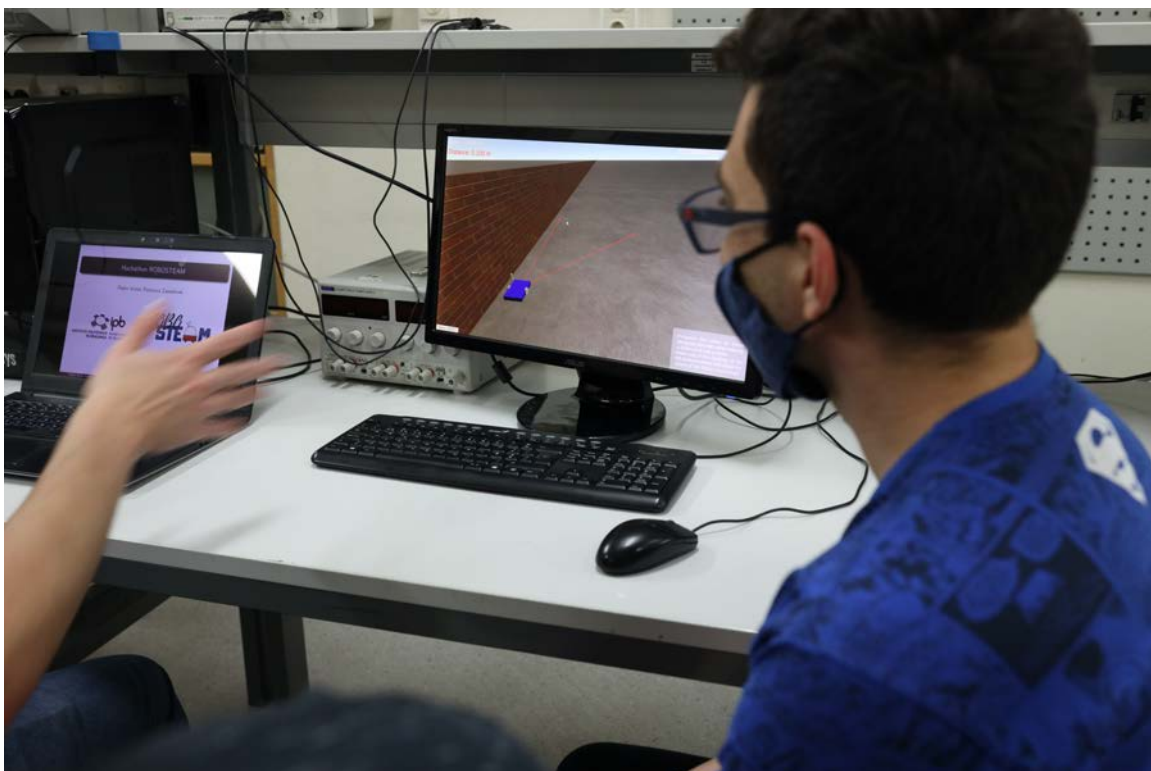


Figure 1. – Students working in testing the Robot in the HIL prototype

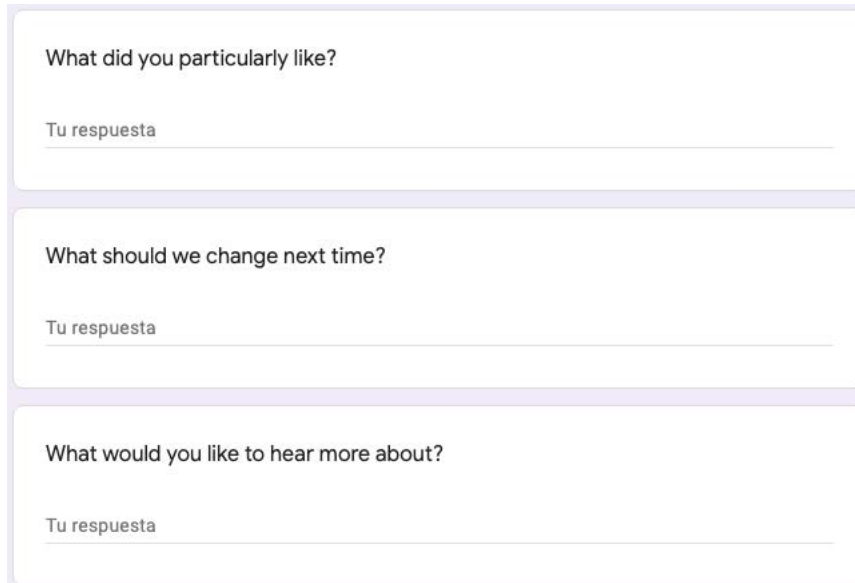
In this case the testing was based more on the perception and feedback of the participants, but in order to register some of this feedback and to validate it a form was published (<https://forms.gle/qdq1EujUTjPFDJ768>). Some pictures of the questions asked to the participants can be seen in Figure 2 and 3.

Multiplier Event Evaluation

How much do you agree with the following statements

	Not at all	Not much	Neutral	Much	Very much
The event was well structured	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The speakers had relevant expertise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The contents were inspiring for my practice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The possibilities for active involvement of participants were adequate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The infrastructure (room, equipment) used in/for the event was adequate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My expectations were met	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 2. – Questions asked to the participants



What did you particularly like?

Tu respuesta

What should we change next time?

Tu respuesta

What would you like to hear more about?

Tu respuesta

Figure 3. - Open questions asked to the participants

2.2. C6 Virtual Exchange

The other testing context was C6, the virtual exchange. It is an exchange that was scheduled to month 18 but that was to be postponed and finally carried out in a virtual way the 21st and 22nd of January of 2021. It includes students from different socioeconomical context from Spain, Portugal and Finland. There were three groups of students from all nationalities involved in the project. All of them with mixed abilities concerning STEAM related competences. Therefore, the groups were heterogeneous. The average age was 15-year-old. There were two Finnish Teachers, four Portuguese teachers and two Spanish teachers. We also had the support of a master students from IPB. Each of the groups has a virtual videoconference room where they can interact and a virtual machine defined with SUFFER where they can collaborate to solve nano-challenges (this is called CINDY). In such machine both the students of a group and teachers can access although only one of the can access at the same time. In order to measure the activity carried out in this C6 survey was used that includes elements of the Technology Acceptance Model (TAM) [24] and the System Usability Scale (SUS) [25]. A link to the survey is the following: <https://forms.gle/ws4WuvsLzEy3679s5>.

TAM is one very popular model to explore technology acceptance, it studies two main factors that influence individuals' intention to use the technology: perceived ease of

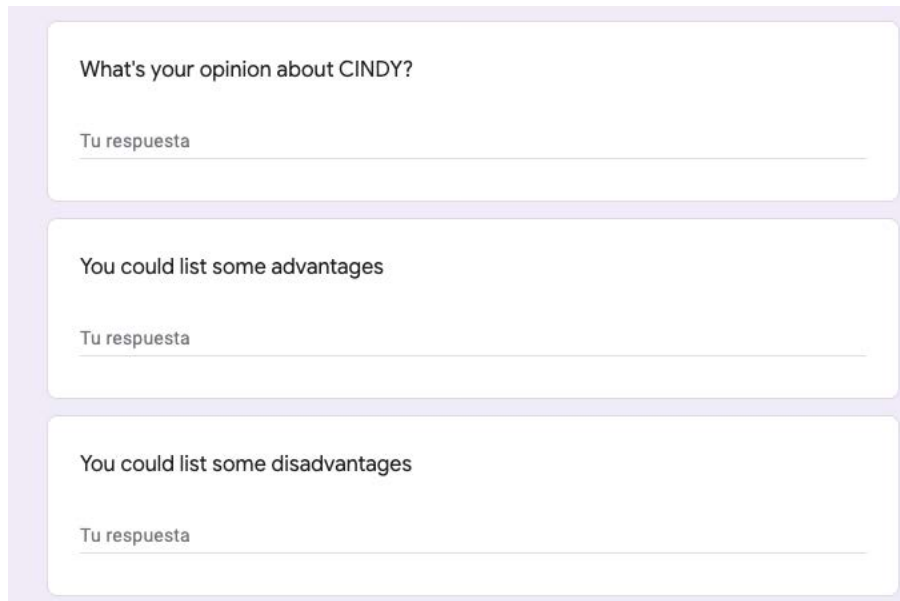
use (PEOF) and perceived usefulness (PU). It has been adapted several times to different contexts a sample can be TAM3 [26]. From this last version several items were extracted and included into a form, a correspondence between the issue that is explored and the question can be seen in table 1.

Table 1. - TAM Items and RoboSTEAM questions

Variable Explored	
Perceived Usefulness (PU)	CINDY would improve my learning performance
	CINDY would improve my academic performance
	CINDY could make it easier to study course content
Perceived ease of use (PEOU)	I find CINDY easy to use
	Learning how to use CINDY is easy for me
	It is easy to become skillful at using CINDY
	I have the necessary skills for using CINDY
Attitude Towards Technology	Programming through CINDY is a good idea
	I am positive toward CINDY
	I intend to be a heavy user of CINDY

Regarding SUS, it is an instrument that provides a simple way to measure usability. It consists of 10 items with five options each (from Strongly Agree to Strongly Disagree). It was created by John Brooke in 1986 and allows to evaluate different products and services [25].

In addition, some open questions were published. They can be seen in Figure 4.



What's your opinion about CINDY?

Tu respuesta

You could list some advantages

Tu respuesta

You could list some disadvantages

Tu respuesta

Figure 4. – Open questions asked to the participants about CINDY

3. Evaluation Results

The results obtained during the evaluation are shown in this section taking into account the Hackaton and the C6.

3.1. Hackathon

Regarding the feedback obtained during the hackaton we had only 4 answers to the survey and most of them with positive feedback. In this case the interesting data are the open questions answers. As they are not to much we paste here those related with the tools:

- What did you particularly like?
 - *“Learn by using simulators that allow you to make quick test and understand what you are doing”*
 - “Using the robots and software to learn”
 - “I particularly appreciated the fact that we tested simulations and tried to make the control of the robots more efficient”
- What should we change next time?
 - “An explanation of the best ways to solve the challenges comparing the different options”

- “more robots and equipment”

It is possible to see that there is a positive feedback regarding the use of the robots simulators and that probably the competition can be improved with more time, robots and simulators.

3.2. C6 Virtual Exchange

In this case we have applied a mixed-methods approach [27], combining quantitative and qualitative analysis. The quantitative analysis will consider TAM results and SUS while the qualitative deals with the open questions. R

Figure 5 presents an overview of TAM questionnaire obtained after STEAM experience to 17 individuals. The results presents high number of responses linked to neutral. However, we observed that they feel confident using CINDY and quite positive about the tool with almost a 47.06 % of respondents agreeing. Around 40% of respondents agreeing in that CINDY will enhance their academic and learning performance. Finally, the number of respondents that totally disagree about the ease of use of CINDY was under 6%.

Figure 6 presents the description of TAM answers. In average we can observe that there is a majority of respondents over the neutral option. The boxplots presented in Figure 8 and 9 illustrates this fact graphically

Figure 10 overviews the same data but presented by gender. In this case we have splitted and analysed the results. Again, for illustrating the data we have generated a boxplot that it is presented in Figure 11 and Figure 12. This figure shows a similar behaviour in mean, however some aspects such as being skilful using Cindy or being a heavy user of Cindy presents a negative scenario.

Finally, when we face the same scenario by age, the TAM presents the set of respondents between 17-18 more confident about the use of CINDY and the perception of their skills. Notwithstanding, at the same time they are the set of individuals that do not fully agree about the positively feeling toward the tool. We should point out that such students age were not the focus of this project, however when they began the project they were in 15-16. Figure 13 presents an overview of this data and Figure 14 and Figure 15 shows the boxplot associated.

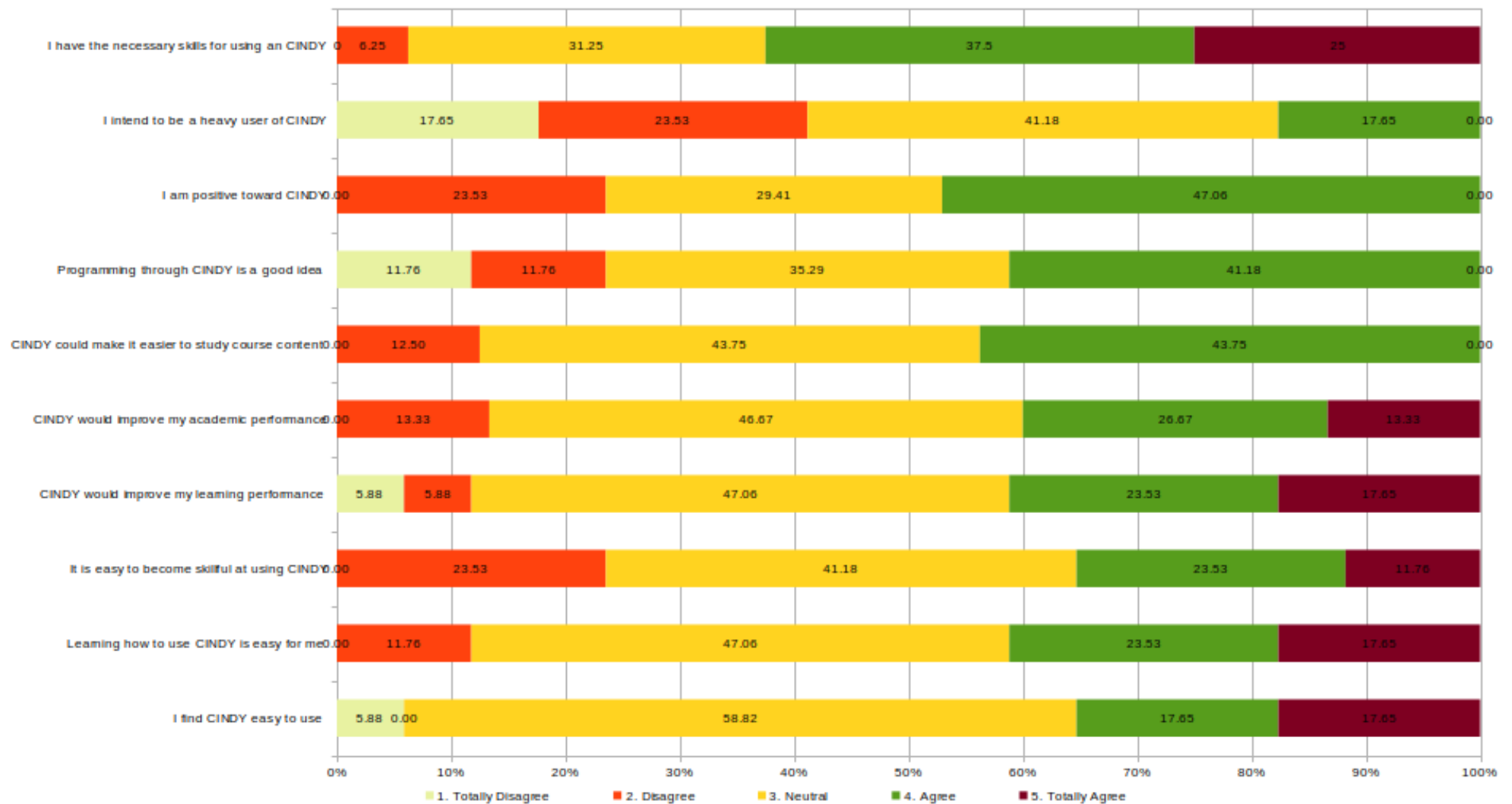


Figure 5. -Overview of answers to TAM Questionnaire

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Descriptive Statistics

	I find CINDY easy to use	Learning how to use CINDY is easy for me	It is easy to become skillful at using CINDY	CINDY would improve my learning performance
Valid	17	17	17	17
Missing	0	0	0	0
Mean	3.412	3.471	3.235	3.412
Median	3.000	3.000	3.000	3.000
Mode ^a	3.000	3.000	3.000	3.000
Std. Deviation	1.004	0.943	0.970	1.064
Minimum	1.000	2.000	2.000	1.000
Maximum	5.000	5.000	5.000	5.000
25th percentile	3.000	3.000	3.000	3.000
50th percentile	3.000	3.000	3.000	3.000
75th percentile	4.000	4.000	4.000	4.000

^a More than one mode exists, only the first is reported

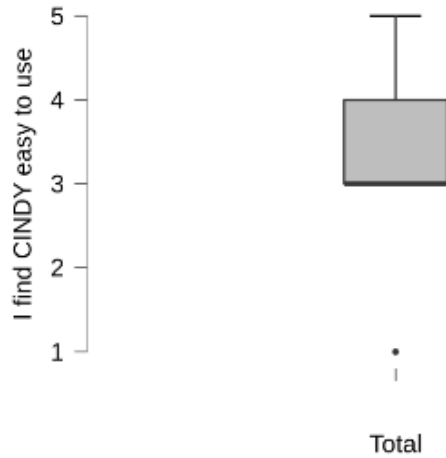
	CINDY could make it easier to study course content	Programming through CINDY is a good idea	I am positive toward CINDY
Valid	16	17	17
Missing	1	0	0
Mean	3.313	3.059	3.235
Median	3.000	3.000	3.000
Mode	3.000	4.000	4.000
Std. Deviation	0.704	1.029	0.831
Minimum	2.000	1.000	2.000
Maximum	4.000	4.000	4.000
25th percentile	3.000	3.000	3.000
50th percentile	3.000	3.000	3.000
75th percentile	4.000	4.000	4.000

	I intend to be a heavy user of CINDY	I have the necessary skills for using an CINDY	CINDY would improve my academic performance
Valid	17	16	15
Missing	0	1	2
Mean	2.588	3.813	3.400
Median	3.000	4.000	3.000
Mode	3.000	4.000	3.000
Std. Deviation	1.004	0.911	0.910
Minimum	1.000	2.000	2.000
Maximum	4.000	5.000	5.000
25th percentile	2.000	3.000	3.000
50th percentile	3.000	4.000	3.000
75th percentile	3.000	4.250	4.000

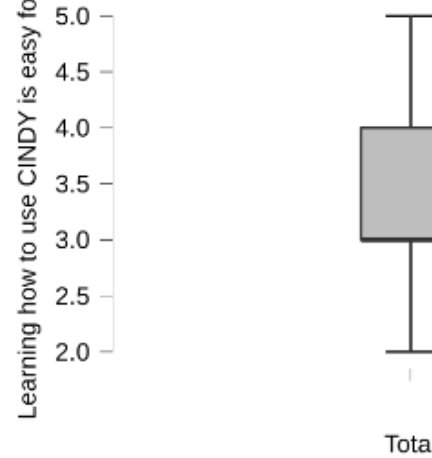
Figure 6. - TAM answers descriptions

Boxplots ▾

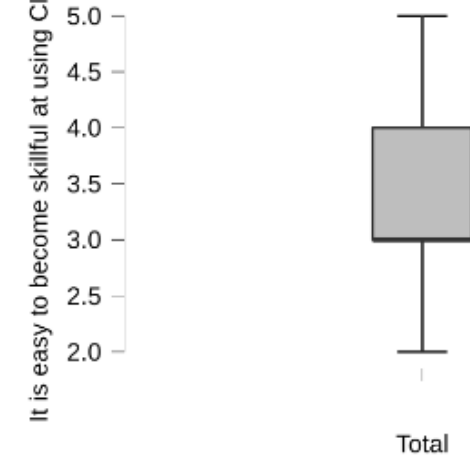
I find CINDY easy to use



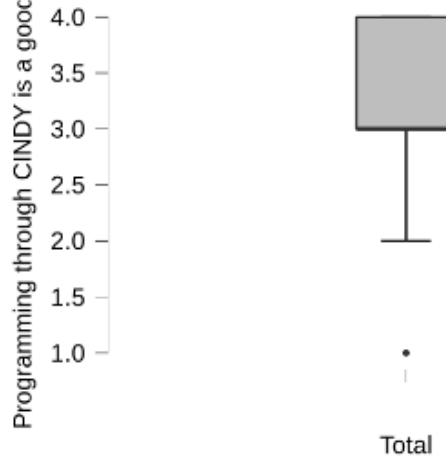
Learning how to use CINDY is easy for me



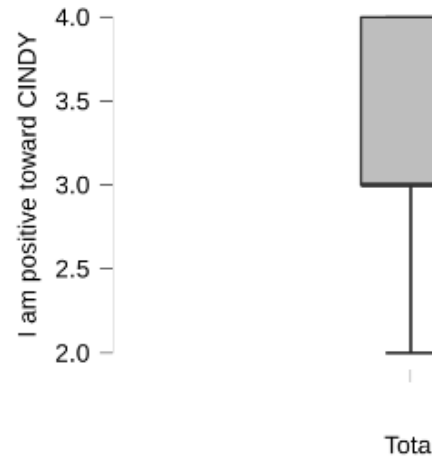
It is easy to become skillful at using CINDY



Programming through CINDY is a good idea



I am positive toward CINDY



I intend to be a heavy user of CINDY

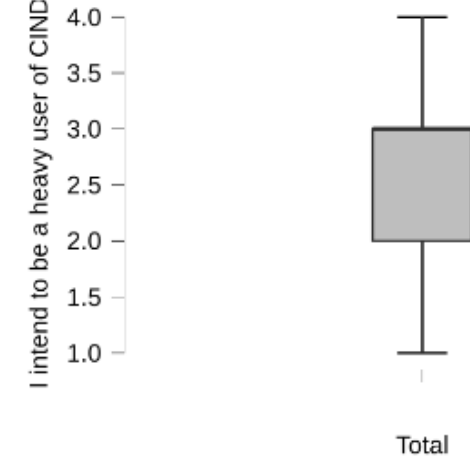


Figure 7. - Answers boxplot1 for answers

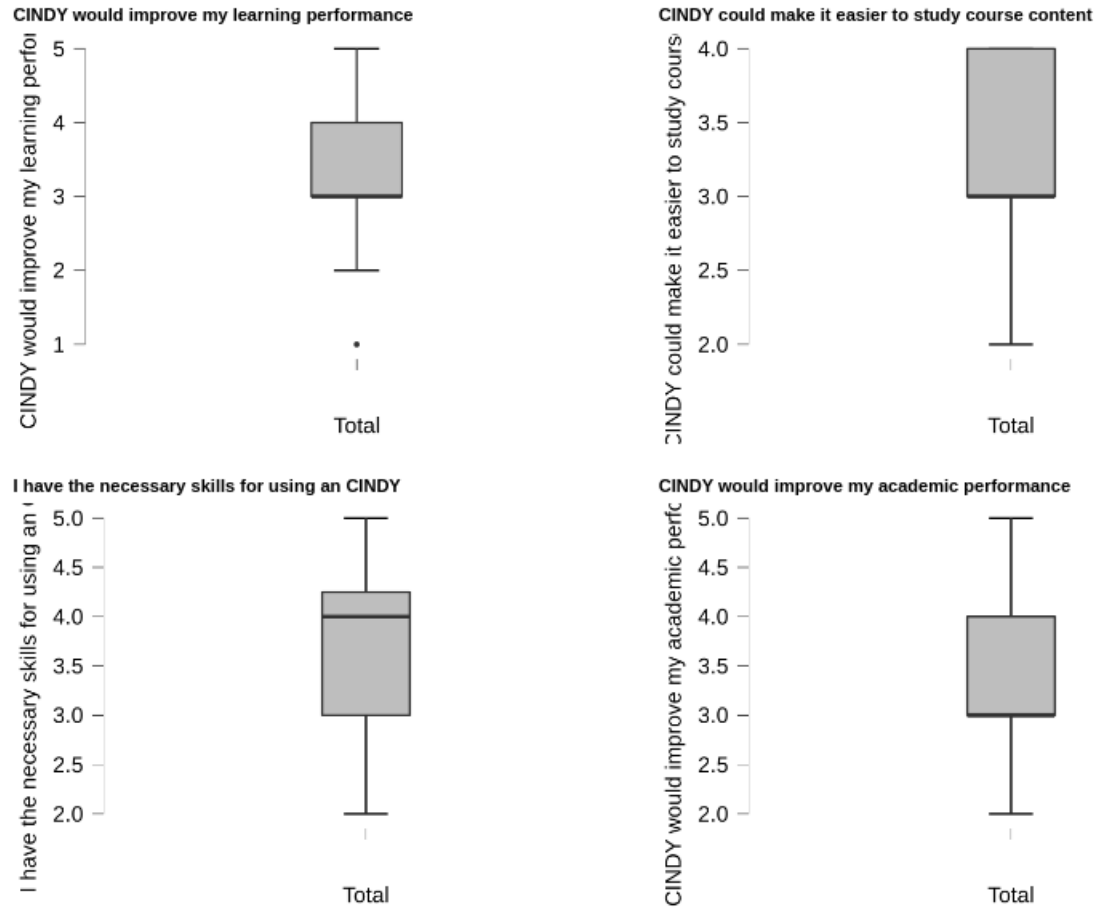


Figure 8. - Answers boxplot2 for answers

Descriptive Statistics

	I find CINDY easy to use		Learning how to use CINDY is easy for me		It is easy to become skillful at using CINDY		CINDY would improve my learning performance	
	Female	Male	Female	Male	Female	Male	Female	Male
Valid	6	11	6	11	6	11	6	11
Missing	0	0	0	0	0	0	0	0
Mean	3.167	3.545	3.333	3.545	3.000	3.364	3.000	3.636
Median	3.000	3.000	3.000	3.000	3.000	3.000	3.000	4.000
Mode ^a	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Std. Deviation	1.329	0.820	1.033	0.934	1.095	0.924	1.265	0.924
Minimum	1.000	3.000	2.000	2.000	2.000	2.000	1.000	2.000
Maximum	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
25th percentile	3.000	3.000	3.000	3.000	2.250	3.000	3.000	3.000
50th percentile	3.000	3.000	3.000	3.000	3.000	3.000	3.000	4.000
75th percentile	3.750	4.000	3.750	4.000	3.000	4.000	3.000	4.000

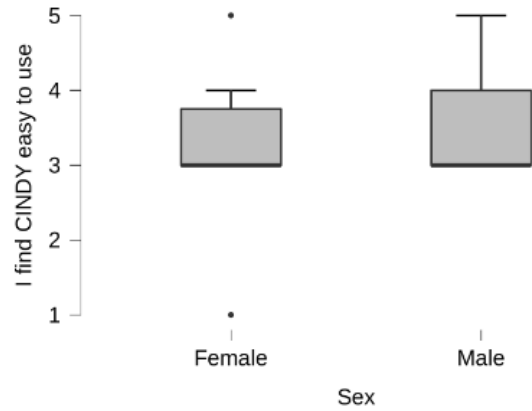
^a More than one mode exists, only the first is reported

	CINDY could make it easier to study course content		Programming through CINDY is a good idea		I am positive toward CINDY		I intend to be a heavy user of CINDY		CINDY would improve my academic performance	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Valid	6	10	6	11	6	11	6	11	5	10
Missing	0	1	0	0	0	0	0	0	1	1
Mean	3.167	3.400	3.500	2.818	3.333	3.182	2.500	2.636	3.000	3.600
Median	3.000	3.500	3.500	3.000	3.500	3.000	3.000	3.000	3.000	3.500
Mode	3.000	4.000	3.000	4.000	4.000	4.000	3.000	2.000	3.000	3.000
Std. Deviation	0.753	0.699	0.548	1.168	0.816	0.874	0.837	1.120	0.707	0.966
Minimum	2.000	2.000	3.000	1.000	2.000	2.000	1.000	1.000	2.000	2.000
Maximum	4.000	4.000	4.000	4.000	4.000	4.000	3.000	4.000	4.000	5.000
25th percentile	3.000	3.000	3.000	2.000	3.000	2.500	2.250	2.000	3.000	3.000
50th percentile	3.000	3.500	3.500	3.000	3.500	3.000	3.000	3.000	3.000	3.500
75th percentile	3.750	4.000	4.000	4.000	4.000	4.000	3.000	3.500	3.000	4.000

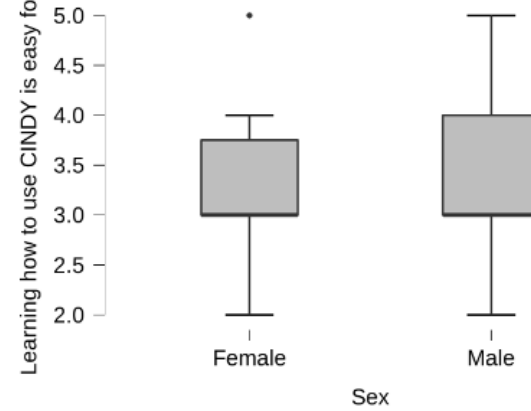
Figure 9. Data description by gender

Boxplots ▾

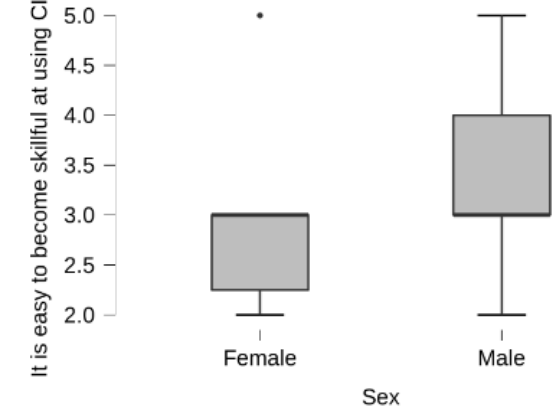
I find CINDY easy to use



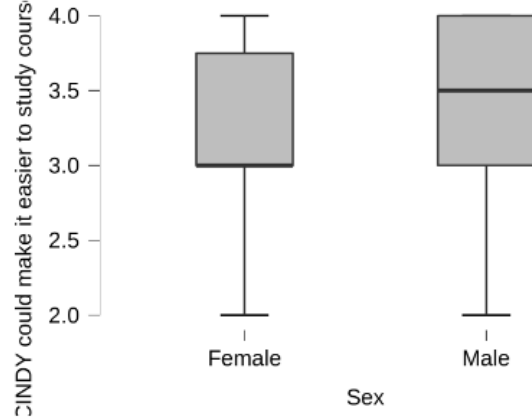
Learning how to use CINDY is easy for me



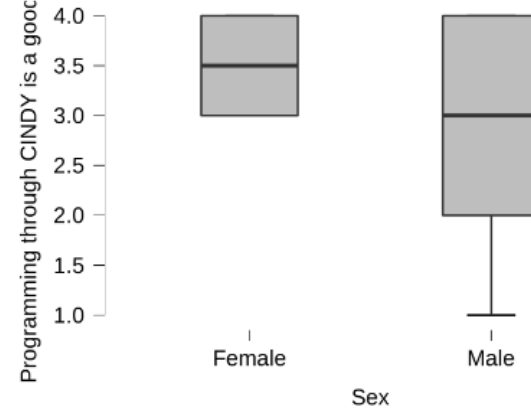
It is easy to become skillful at using CINDY



CINDY could make it easier to study course content



Programming through CINDY is a good idea



I am positive toward CINDY

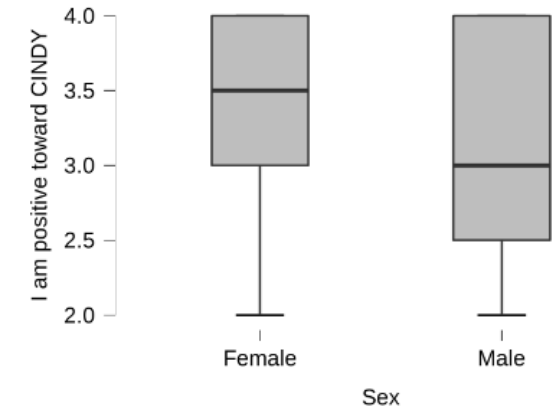


Figure 10. - Answers boxplot1 for answers by gender

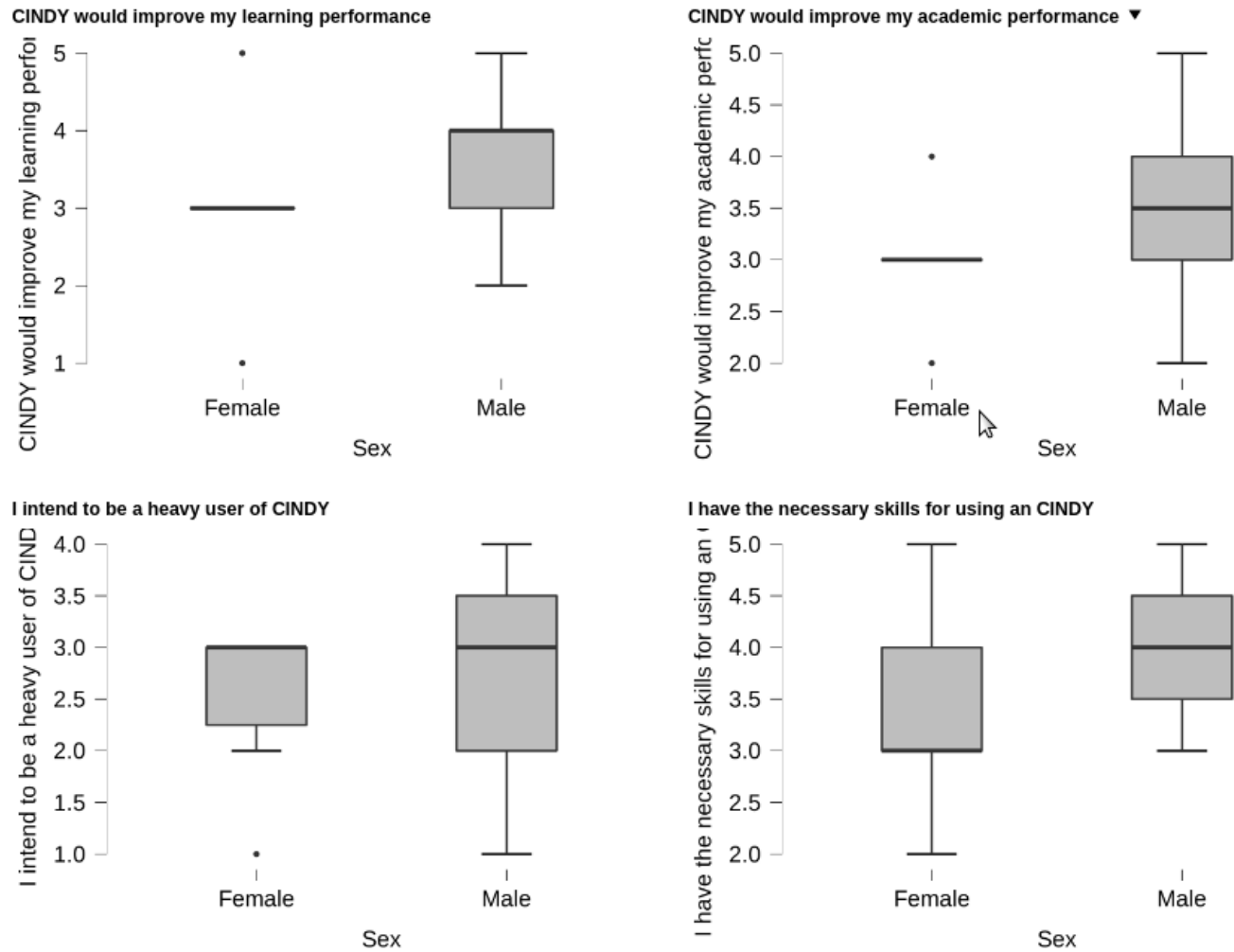


Figure 11. - Answers boxplot1 for answers by gender

2018-1-ES01-KA201-050939

Descriptive Statistics

	I find CINDY easy to use			Learning how to use CINDY is easy for me			It is easy to become skillful at using CINDY			CINDY would improve my learning performance		
	17-18	40-50	50-100	17-18	40-50	50-100	17-18	40-50	50-100	17-18	40-50	50-100
Valid	13	2	2	13	2	2	13	2	2	13	2	2
Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean	3.385	3.000	4.000	3.385	3.500	4.000	3.231	3.000	3.500	3.308	3.500	4.000
Median	3.000	3.000	4.000	3.000	3.500	4.000	3.000	3.000	3.500	3.000	3.500	4.000
Mode ^a	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	2.000	3.000	3.000	3.000
Std. Deviation	1.044	0.000	1.414	0.961	0.707	1.414	0.927	0.000	2.121	1.109	0.707	1.414
Minimum	1.000	3.000	3.000	2.000	3.000	3.000	2.000	3.000	2.000	1.000	3.000	3.000
Maximum	5.000	3.000	5.000	5.000	4.000	5.000	5.000	3.000	5.000	5.000	4.000	5.000
25th percentile	3.000	3.000	3.500	3.000	3.250	3.500	3.000	3.000	2.750	3.000	3.250	3.500
50th percentile	3.000	3.000	4.000	3.000	3.500	4.000	3.000	3.000	3.500	3.000	3.500	4.000
75th percentile	4.000	3.000	4.500	4.000	3.750	4.500	4.000	3.000	4.250	4.000	3.750	4.500

^a More than one mode exists, only the first is reported

	CINDY could make it easier to study course content			Programming through CINDY is a good idea			I am positive toward CINDY			I intend to be a heavy user of CINDY			I have the necessary skills for using an CINDY			CINDY would improve my academic performance		
	17-18	40-50	50-100	17-18	40-50	50-100	17-18	40-50	50-100	17-18	40-50	50-100	17-18	40-50	50-100	17-18	40-50	50-100
Valid	12	2	2	13	2	2	13	2	2	13	2	2	12	2	2	11	2	2
Missing	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0
Mean	3.250	3.500	3.500	2.846	3.500	4.000	3.077	3.500	4.000	2.385	3.500	3.000	4.000	3.500	3.000	3.364	3.500	3.500
Median	3.000	3.500	3.500	3.000	3.500	4.000	3.000	3.500	4.000	2.000	3.500	3.000	4.000	3.500	3.000	3.000	3.500	3.500
Mode	3.000	3.000	3.000	3.000	3.000	4.000	4.000	3.000	4.000	2.000	3.000	3.000	3.000	3.000	2.000	3.000	3.000	3.000
Std. Deviation	0.754	0.707	0.707	1.068	0.707	0.000	0.862	0.707	0.000	1.044	0.707	0.000	0.853	0.707	1.414	1.027	0.707	0.707
Minimum	2.000	3.000	3.000	1.000	3.000	4.000	2.000	3.000	4.000	1.000	3.000	3.000	3.000	3.000	2.000	2.000	3.000	3.000
Maximum	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	3.000	5.000	4.000	4.000	5.000	4.000	4.000
25th percentile	3.000	3.250	3.250	2.000	3.250	4.000	2.000	3.250	4.000	2.000	3.250	3.000	3.000	3.250	2.500	3.000	3.250	3.250
50th percentile	3.000	3.500	3.500	3.000	3.500	4.000	3.000	3.500	4.000	2.000	3.500	3.000	4.000	3.500	3.000	3.000	3.500	3.500
75th percentile	4.000	3.750	3.750	4.000	3.750	4.000	4.000	3.750	4.000	3.000	3.750	3.000	5.000	3.750	3.500	4.000	3.750	3.750

Figure 12. – Answers description based on age

Alternatively, we have used Spearman's correlation coefficient to examine the strength and direction of the monotonic relationship between our ordinal variables (Likert). In a monotonic relationship, the variables tend to move in the same relative direction, but not necessarily at a constant rate. For Spearman's correlation, an absolute value of 1 indicates that the rank-ordered data is perfectly linear; -1 means that the highest value of Variable A is associated with the lowest value of Variable B, the second highest value of Variable A is associated with the second lowest value of Variable B and so on. Attending the direction, the sign of the coefficient indicates the direction of the relationship, that tend to increase or decrease at the same time. An example where the coefficient is positive and the line representing the correlation slopes upward. If one variable tends to increase while the other decreases, the coefficient is negative and the line representing the correlation slopes downward.

Figures 13 and 14 illustrates the correlation and presents that there is a correlation between to find CINDY easy to use and the other variables. However, the item "I have the necessary skills for using CINDY" the coefficient is negative with "Programming through CINDY is a good idea", "I am positive toward CINDY" and "I intended to be a heavy user of CINDY".

Learning how to use CINDY is easy to become skillful at using could improve my learning could improve my academic could make it easier to study counting through CINDY is a goal I am positive toward CINDY and to be a heavy user of CINDY necessary skills for using a

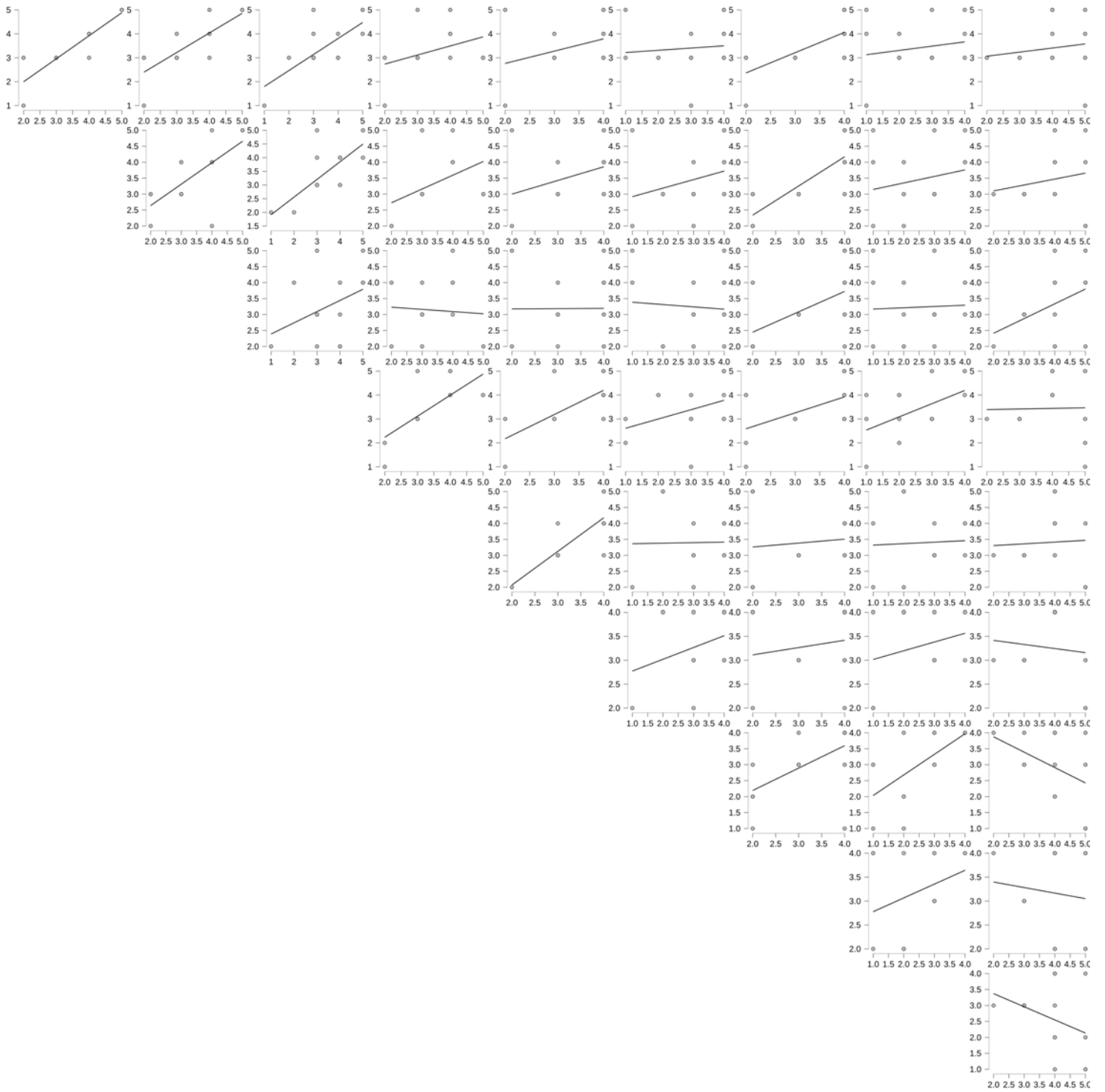


Figure 13. – Correlation description

Spearman's Correlations ▼

Variable		I find CINDY easy to use	Learning how to use CINDY is easy for me	It is easy to become skillful at using CINDY	CINDY would improve my learning performance
1. I find CINDY easy to use	Spearman's rho	—			
	p-value	—			
2. Learning how to use CINDY is easy for me	Spearman's rho	0.910	—		
	p-value	3.990e-7	—		
3. It is easy to become skillful at using CINDY	Spearman's rho	0.792	0.652	—	
	p-value	1.507e-4	0.005	—	
4. CINDY would improve my learning performance	Spearman's rho	0.604	0.706	0.316	—
	p-value	0.010	0.002	0.216	—
5. CINDY would improve my academic performance	Spearman's rho	0.408	0.560	-0.015	0.776
	p-value	0.131	0.030	0.958	6.751e-4
6. CINDY could make it easier to study course content	Spearman's rho	0.329	0.406	0.056	0.701
	p-value	0.214	0.119	0.836	0.003
7. Programming through CINDY is a good idea	Spearman's rho	0.256	0.416	0.070	0.387
	p-value	0.321	0.097	0.790	0.125
8. I am positive toward CINDY	Spearman's rho	0.749	0.849	0.548	0.477
	p-value	5.340e-4	1.614e-5	0.023	0.053
9. I intend to be a heavy user of CINDY	Spearman's rho	0.101	0.254	0.115	0.450
	p-value	0.701	0.326	0.659	0.070
10. I have the necessary skills for using an CINDY	Spearman's rho	0.275	0.173	0.399	0.131
	p-value	0.303	0.521	0.126	0.630

CINDY would improve my academic performance	CINDY could make it easier to study course content	Programming through CINDY is a good idea	I am positive toward CINDY	I intend to be a heavy user of CINDY	I have the necessary skills for using an CINDY
—					
—					
0.778	—				
0.001	—				
0.044	0.245	—			
0.877	0.360	—			
0.223	0.212	0.636	—		
0.425	0.431	0.006	—		
0.061	0.139	0.666	0.353	—	
0.830	0.607	0.004	0.164	—	
0.118	0.019	-0.321	-0.040	-0.339	—
0.676	0.948	0.226	0.884	0.199	—

Figure 14. – Spearman correlation results

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Table 2. - Matrix of results of students answers

	Q1 (opinion)	Q2 (advantages)	Q3 (disadvantages)
St1	Good but needs improvement	Synchronize everyone's work	Confusing at the beginning
St2	Good platform	It improves team work	None
St3	Indifferent	Good for remote learning	One person at the same time
St4	Indifferent	Indifferent	Indifferent
St5	Good idea requires work	Motivates students	Difficult with bad network
St6	Needs improvement	Working at home	Needs improvements
St7	Difficult to work with others	None	Lot of them
St8	Good collaboration tool	Teamwork	The same screen for all
St9	Confusing	Collaborative work, sharing ideas	None
St10	Good idea with the pandemic	Work with other	None
St11	Good overall	Work as a team	Connection troubles
S12	Needs improvement	Intuitive	Lot of improvement

4. ACKNOWLEDGEMENTS

This document has been developed within ROBOSTEAM Erasmus+ KA201 Project with reference 2018-1-ES01-KA201-050939.

This project has been funded with support from the European Commission. This communication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

5. REFERENCES

- [1] RoboSTEAM Consortium, "RoboSTEAM Project," presented at the RoboSTEAM Erasmus+ project Kick-Off, Bragança, Portugal, February 15-16, 2019, 2019. [Online]. Available: <https://goo.gl/Ni43mK>.
- [2] M. Á. Conde *et al.*, "RoboSTEAM - A Challenge Based Learning Approach for integrating STEAM and develop Computational Thinking," in *TEEM'19 Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality (Leon, Spain, October 16th-18th, 2019)*, M. Á. Conde-González, F. J. Rodríguez-Sedano, C. Fernández-Llamas, and F. J. García-Peñalvo Eds. New York, NY, USA: ACM, 2019, pp. 24-30.
- [3] J. Gonçalves *et al.*, "Educational Robotics Summer Camp at IPB: A Challenge based learning case study," in *TEEM'19 Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality (Leon, Spain, October 16th-18th, 2019)*, M. Á. Conde-González, F. J. Rodríguez-Sedano, C. Fernández-Llamas, and F. J. García-Peñalvo Eds. New York, NY, USA: ACM, 2019, pp. 36-43.
- [4] C. Fernández-Llamas and M. Á. Conde-González, "RoboSTEAM Project – A brief review," 2019. [Online]. Available: <https://zenodo.org/record/3531941>.
- [5] M. Á. Conde, F. J. Rodríguez Sedano, C. Fernández-Llamas, J. Gonçalves, J. Lima, and F. J. García-Peñalvo, "RoboSTEAM Project Systematic Mapping: Challenge Based Learning and Robotics," in *2020 IEEE Global Engineering*

- Education Conference (EDUCON), (27-30 April 2020, Porto, Portugal). USA: IEEE, 2020, pp. 214-221.*
- [6] M. Á. Conde *et al.*, "Exchanging Challenge Based Learning Experiences in the Context of RoboSTEAM Erasmus+ Project," in *Learning and Collaboration Technologies. Design, Experiences. 7th International Conference, LCT 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part I*, P. Zaphiris and A. Ioannou Eds., (Lecture Notes in Computer Science, no. 12205). Cham, Switzerland: Springer Nature, 2020, pp. 442-455.
- [7] M. Á. Conde *et al.*, "Adaption of RoboSTEAM Project to the Pandemic Situation," in *Proceedings TEEM'20. Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality (Salamanca, Spain, October 21st - 23rd, 2020)*, F. J. García-Peñalvo Ed., (ICPS: ACM International Conference Proceedings Series. New York, NY, USA: ACM, 2020.
- [8] M. Á. Conde, F. J. Rodríguez-Sedano, C. Fernández-Llamas, J. Gonçalves, J. Lima, and F. J. García-Peñalvo, "Fostering STEAM through Challenge Based Learning, Robotics and Physical Devices: A systematic mapping literature review," *Computer Application in Engineering Education*, vol. 29, pp. 46-65, 2021, doi: 10.1002/cae.22354.
- [9] H. Fardoun, C. S. González-González, C. A. Collazos, and M. Yousef, "Estudio exploratorio en Iberoamérica sobre procesos de enseñanza-aprendizaje y propuesta de evaluación en tiempos de pandemia," *Education in the Knowledge Society*, vol. 21, 2020, Art no. 17, doi: 10.14201/eks.23537.
- [10] F. J. García-Peñalvo, A. Corell, V. Abella-García, and M. Grande-de-Prado, "Online Assessment in Higher Education in the Time of COVID-19," *Education in the Knowledge Society*, vol. 21, 2020, Art no. 12, doi: 10.14201/eks.23013.
- [11] J. Cabero-Almenara and C. Llorente-Cejudo, "Covid-19: radical transformation of digitization in university institutions," *Campus Virtuales*, vol. 9, no. 2, pp. 25-34, 2020.

- [12] S. J. Daniel, "Education and the COVID-19 pandemic," *PROSPECTS*, 2020, doi: 10.1007/s11125-020-09464-3.
- [13] Á. Fidalgo-Blanco, M. L. Sein-Echaluce, and F. J. García-Peñalvo, "Hybrid Flipped Classroom: adaptation to the COVID situation," in *Proceedings TEEM'20. Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality (Salamanca, Spain, October 21st - 23rd, 2020)*, F. J. García-Peñalvo Ed., (ICPS: ACM International Conference Proceedings Series. New York, NY, USA: ACM, 2020.
- [14] F. J. García-Peñalvo and A. Corell, "La COVID-19: ¿enzima de la transformación digital de la docencia o reflejo de una crisis metodológica y competencial en la educación superior?," *Campus Virtuales*, vol. 9, no. 2, pp. 83-98, 2020.
- [15] F. J. García-Peñalvo, A. Corell, V. Abella-García, and M. Grande-de-Prado, "Recommendations for Mandatory Online Assessment in Higher Education During the COVID-19 Pandemic," in *Radical Solutions for Education in a Crisis Context. COVID-19 as an Opportunity for Global Learning*, D. Burgos, A. Tlili, and A. Tabacco Eds., (Lecture Notes in Educational Technology. Singapore, Singapore: Springer Nature, 2021, ch. 7, pp. 85-98.
- [16] F. J. García-Peñalvo, A. Corell, R. Rivero-Ortega, M. J. Rodríguez-Conde, and N. Rodríguez-García, "Impact of the COVID-19 on Higher Education: An Experience-Based Approach," in *Information Technology Trends for a Global and Interdisciplinary Research Community*, F. J. García-Peñalvo Ed., (Advances in Human and Social Aspects of Technology (AHSAT) Book Series. Hershey, PA, USA: IGI Global, 2021, ch. 1, pp. 1-18.
- [17] M. Nicola *et al.*, "The socio-economic implications of the coronavirus pandemic (COVID-19): A review," *International Journal of Surgery*, vol. 78, pp. 185-193, 2020, doi: 10.1016/j.ijssu.2020.04.018.
- [18] W. Van Lancker and Z. Parolin, "COVID-19, school closures, and child poverty: a social crisis in the making," *The Lancet Public Health*, vol. 5, no. 5, pp. e243-e244, 2020, doi: 10.1016/S2468-2667(20)30084-0.

- [19] R. M. Viner *et al.*, "School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review," *The Lancet Child & Adolescent Health*, vol. 4, no. 5, pp. 397-404, 2020, doi: 10.1016/S2352-4642(20)30095-X.
- [20] RoboSTEAM Consortium, "O3.COVID-19_1 – Implementation and adaption of tools for RoboSTEAM in COVID-19 times (Version 1.2.2)," RoboSTEAM Consortium, European Union, May 29 2021. [Online]. Available: <http://doi.org/10.5281/zenodo.4841119>
- [21] RoboSTEAM Consortium, "RoboSTEAM Project Management Handbook (Version 1.1.3)," RoboSTEAM Consortium, European Union, May 29 2021. [Online]. Available: <http://doi.org/10.5281/zenodo.4841095>
- [22] Á. Fidalgo-Blanco, M. L. Sein-Echaluce Lacleta, and F. J. García-Peñalvo, "Aprendizaje Basado en Retos en una asignatura académica universitaria," *IE Comunicaciones. Revista Iberoamericana de Informática Educativa*, no. 25, pp. 1-8, 2017.
- [23] Observatorio de Innovación Tecnológica del Tecnológico de Monterrey, *Aprendizaje basado en retos*, Monterrey, México: Tecnológico de Monterrey, 2015. [Online]. Available: <https://goo.gl/k8NfnS>.
- [24] F. D. Davis, R. P. Bagozzi, and P. R. Warshaw, "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science*, vol. 35, no. 8, pp. 982-1003, 1989, doi: 10.1287/mnsc.35.8.982.
- [25] J. Sauro, *A Practical Guide to the System Usability Scale: Background, Benchmarks & Best Practices*. CreateSpace, 2011.
- [26] V. Venkatesh and H. Bala, "Technology Acceptance Model 3 and a Research Agenda on Interventions," *Decision Sciences*, vol. 39, no. 2, pp. 273-315, 2008, doi: doi: 10.1111/j.1540-5915.2008.00192.x.
- [27] J. L. Green, G. Camilli, and P. B. Elmore, *Handbook of Complementary Methods in Education Research*. American Educational Research Association by Lawrence Erlbaum Associates, Inc, 2006.

- [28] M. B. Miles and A. M. Huberman, *Qualitative Data Analysis: An Expanded Sourcebook*. Sage Publications, 1994.