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The Effectiveness and Impact of Teaching Coding through Scratch on Moroccan Pupils' Competencies

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Abstract: Coding for pupils has become a new trend in information communication technology (ICT) education as it is a gateway to the new digital era for future generations where computers are one of the backbones of modern society. In this respect, the present study aimed at investigating the usefulness and impact of teaching coding through "Scratch" (i.e., a coding software for pupils) on Moroccan pupils, measuring their capacity to learn coding and finally exploring Moroccan teachers' perceptions about it. Therefore, a pre-test post-test experimental course study took place targeting 38 pupils of the 6th grade in a rural area school. The control group (19 participants) was not taught the basics of Scratch coding while the experimental group (19 participants) was taught through practical Scratch coding initiation lessons based on the theory-based model for computer programming teaching. Furthermore, a quantitative survey questionnaire was used to gather 5th and 6th grade teachers (202 participants) perceptions about Scratch. The Statistical Package for Social Sciences was used to analyze the data. The results of the quantitative questionnaire showed that Moroccan teachers endorse Scratch teaching for its potential benefits while the experimental study results proved that computer coding can be easily be integrated in Moroccan schools. The software is suitable for the students since they demonstrated significant interest in coding and have experienced positive impacts on various competencies.

Index Terms: Scratch software, Coding for young learners, ICT in education, Computing education, Digital fluency.

1. Introduction

Information communication technology has become an integral part of the education system worldwide. Teachers, therefore, are increasingly relying on ICT in delivering pedagogical content to their students for what these technological tools have to offer in increasing interactivity, attention, ease of the instruction process, concreteness of knowledge, etc. More specifically, teaching coding/programming basics, as early as possible, has become one of the educational trends in ICT education in many countries including Morocco.

The Moroccan ministry of education (MME) has, accordingly, taken a great deal of measures to implement ICT in the Moroccan education system in all its phases. The Genie (programme de généralisation des technologies d'information et de communication) program, inaugurated in 2006, was the kickstart of the national ICT generalization strategy in the education sector. Genie aimed at paving the ICT infrastructure so as to provide multimedia classrooms connected to the internet in every educational institution in Morocco. It aimed, as well, at training teachers to easily use and integrate ICT tools in their classroom practices. Furthermore, the national laboratory for digital resources was founded in order to boost the same strategy.

The MME continued its efforts in ICT integration through other programs for both teachers and students. The recent aspect of the integration was the addition of a coding module in the "scientific activity" subject dedicated to teaching coding basics for 5th and 6th grade pupils starting from the school year 2020/2021 [23]. The coding lessons are an introduction to using the coding software "Scratch".

In this respect, the present paper aims at measuring the effectiveness and impact of teaching coding through Scratch on Moroccan pupils' various competencies which is the main problem to be explored while also measuring the capacity of Moroccan pupils to learn coding in a rural area with little or no ICT literacy. Therefore, this study aims at answering the following research questions:

(i) What is the impact of teaching coding on Moroccan pupils' competencies?
(ii) To which extent is the coding software "Scratch" effective in teaching coding basics in the Moroccan context?
(iii) How do Moroccan teachers perceive Scratch in particular and coding for pupils in general?

By answering these questions, we hope to unveil whether teaching coding was and is effective in a third-world country such as Morocco since almost all the reviewed literature endorsed teaching coding in other countries and showed that it has many positive effects on many levels (for both students and teachers). We are also measuring what has been achieved so far concerning this newly adopted subject unit and how teachers are interacting with it.

In order to answer these questions, we opted for two data collection techniques. For teachers' perceptions, we used a quantitative online survey distributed through a link via school principals. The survey measures the level of agreement of the target sample, chosen by purposive homogenous sampling, with thirteen statements measuring the impact of Scratch on learners' enthusiasm to learn coding, confidence-level afterwards, course enjoyment, capacity to learn coding, and the impact on other subjects. For teachers, we measured how comfortable they feel using Scratch, whether they use it to create course material for other subjects and how likely would they recommend its use. The second data collection method is an experiment where both experiment groups, chosen by random sampling, were tested in order to measure their progress in a well-defined Scratch course and how successful they were at performing all the required tasks.

The next section will provide an overview of Scratch, how it is presented, how it is taught, and how effective it was in other countries.

2. Literature Review

2.1. Scratch overview

Ref. [1] define Scratch as a visual programming environment that permits users (primarily ages 8 to 16) to learn computer programming while working on personally meaningful projects such as animated stories and games. The same software can help both teachers and students to create useful materials while learning the basics of coding implicitly. The MME has launched training workshops remotely for teachers by providing them with access to a Scratch mooc (e. g. the regional academy of Fes Meknes has a mooc online for the same purpose).

Ref. [4] described the third-millennial generation as "digital natives" [2, 3]. That is because they are susceptible to easily consume ready-made new technology. Therefore, the basic idea behind Scratch, when launched back in 2007 by the Massachusetts Institute of Technology (MIT) Media Lab, was to hand over a user-friendly programming tool to young learners in order to enable them to create their own digital products. In other words, to make them "design, create, and invent" technology and not just "manipulate" it. Also, Scratchers "learn important mathematical and computational concepts, while also learning to think creatively, reason systematically, and work collaboratively – essential skills for the 21st century" [2, p. 2]. Scratch, however, does not aim to train professional programmers, "but rather to nurture the development of a new generation of creative, systematic thinkers who are comfortable using programming to express their ideas." [2, p. 2] as programming provides us with opportunities to "reflect on our own thinking and even to think about thinking itself" [2, p. 4]

Similarly, the skills targeted by the Moroccan sixth grade official text book [5], according to the respective teachers' guide and that are essential to the 21 century, are: "the student is supposed to learn how to find his bearings, orient himself/herself using landmarks; adopt a scientific approach: use of a specific language, control, trial and error; and develop abstraction: learn to anticipate the effect of a sequence of instructions before even having it executed by a machine or a program" i.e., *"1) Se repérer, s'orienter en utilisant des repères; 2) Adopter une démarche scientifique: utilisation d'un langage spécifique, contrôle, essais, erreurs ; 3) Développer l'abstraction : apprendre à anticiper l'effet de telle ou telle séquence d'instructions avant même de la faire exécuter par une machine ou un programme."* [5]. In this context, Kreitzberg and Swanson (1974) found that even when students had learned concepts, they could not readily apply them to programming skills [6]. Thus, in order to teach programming skills (tracing code, explaining code and writing code) effectively requires teaching them in sequences [6].

ICT integration in teaching was manifested in many articles worldwide, an example of which was the article studying the effectiveness of an educational software system (Desire2Learn) in teaching English grammar where [7] found out that the software was effective in teaching some grammar lessons versus regular chalk and talk teaching. Although this article is not relevant to coding, however, it was taken as a reference as general example of how ICT could ease the process of learning in other subjects.

Furthermore, in a recent article by [8], students were introduced to "machine learning for kids" and Scratch 3 programming language along with Lego Mindstorms EV3 robots. The results showed that the tools and technologies were suitable for K-12 students, also when used in the form of online training. Pre and post surveys showed that students express basic knowledge in machine learning and great interest in coding and science, technology, engineering and mathematics (STEM) after being exposed to the proposed training. Accordingly, a great deal of other studies on Scratch showed positive results in terms of effectiveness and impact on other subjects whether in favor of students or teachers or both, see [9, 10, 11, 12, 13]. Namely, in [9] experiment, in just two weeks, through a curriculum not completely focused on computer science, students showed competence with event-driven programming, initialization of state, message passing, and say/sound synchronization. Also, in the experiment course of [11], the researchers came to the conclusion that Scratch-based coding experiences enhanced novices' flow levels and achievement of programming.

Concerning the views of teachers about Scratch, [10] and [23] measured teachers' attitudes towards computers programing through Scratch, the results yielded significant increases in the mean of the preservice IT teachers' self-efficacy perceptions regarding almost all complex programming tasks while [12] designed a new course to train undergraduate computer science majors to teach coding concepts to middle school students using Scratch which has reported positive results.

Going back in time and more specifically to the 90s and early years of the third millennial, there have been attempts to introduce programming to children and teens such as Flash/ActionScript as in [2], Alice and Squeak Etoys in [2], but most of them failed because they were difficult to use, with proposed activities that did not connect with young people's interests and in contexts where no one had enough expertise to provide guidance [3]. The scratch programmers built upon these failures and added some childish features for it to be appealing to kids. [2, p. 5] stated that "The Scratch grammar is based on a collection of graphical "programming blocks" all like Lego toys as [3, p. 5] argue, "This approach eliminates syntax errors which have proven to be a major obstacle for learning text-based programming languages". The blocks perform different tasks. Children mix the blocks and see what happens. Indeed, while being trained to teach Scratch to pupils, we found the interface to be user-friendly, multi-lingual, with catchy colors, and no apparent complicated codes. The following is an idea about how blocks are shaped within Scratch:

> *Structures like forever and repeat are C-shaped to suggest that blocks should be placed inside – and to indicate scoping. Blocks that output values are shaped according to the types of values they return: ovals for numbers and hexagons for booleans. Conditional blocks (like if and repeat-until) have a hexagon-shaped voids, indicating a Boolean is required.* [2]

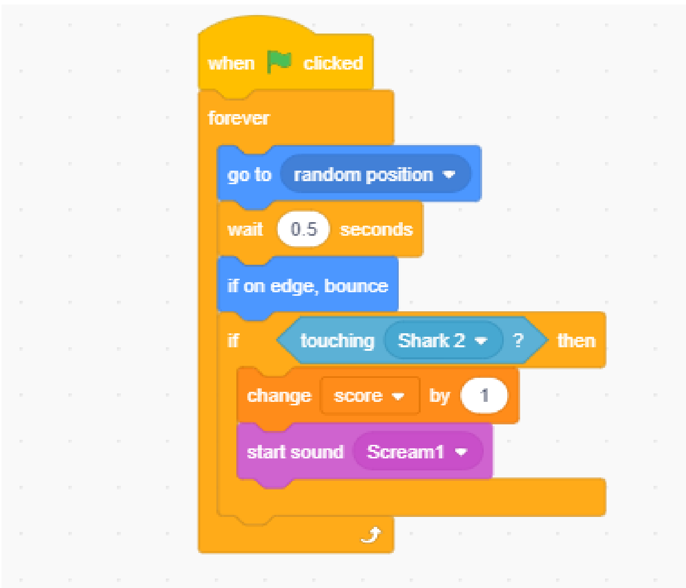

Fig.1. Scratch 3.0 sample blocks

The Scratch 3.26.0, subject of the study shown in Fig. 2, is divided into five sections: code, customs, sounds, blocks (Fig. 1), and a preview section. The blocks can be dragged into the code area and previewed on the spot on the preview window. The customs area is dedicated to manipulating the "sprite" (the character (s) chosen for the game or animation). The preview window is an orthonormal basis where the sprite moves according to the coding blocks. The sounds can be played for better animation.

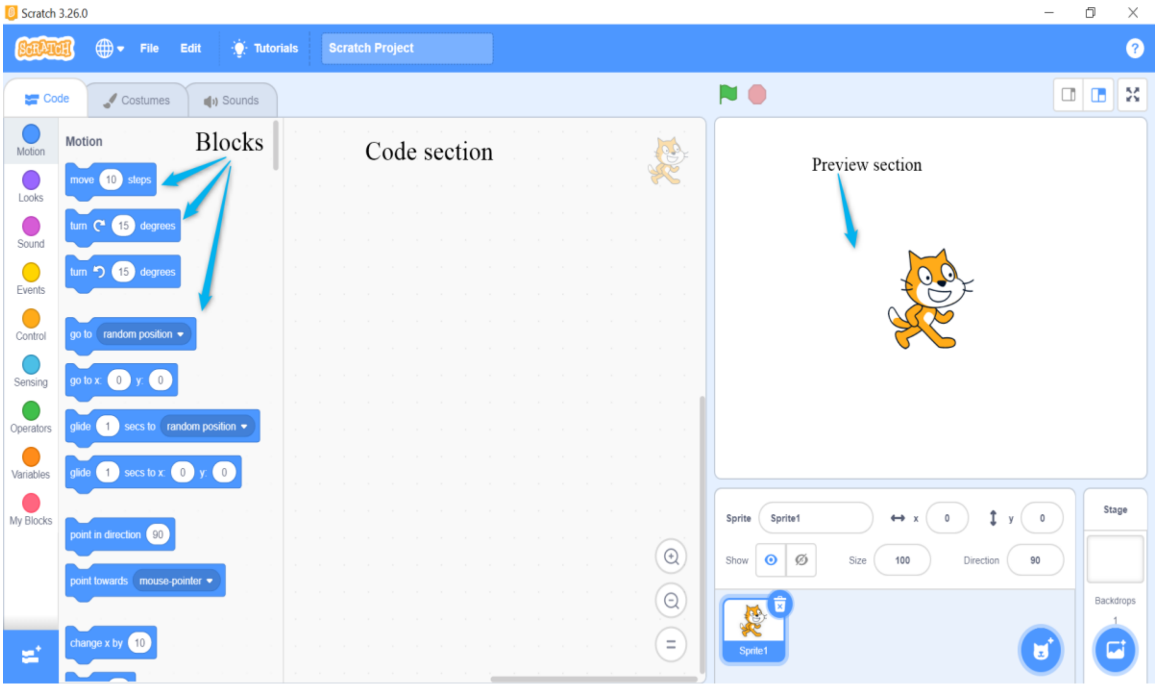

Fig.2. Scratch presentation

2.2. Theoretical framework

In order to conduct an effective computer programming course, we had to base our courses on a related theory besides the school manuals addressed to the participants and the teachers' guide for that matter. Our choice landed on the theory-based design pedagogical framework for an e-Learning course initially developed by [14] and further enhanced by [15]. As can be inferred from Fig. 3, the pedagogical model was based on experiences and knowledge sharing which was mediated through learning technologies (i.e., Scratch software, computer, data show, etc.) and delivered by instructional strategies (i.e., teacher-pupil and peer to peer collaboration) and scaffolding (i.e., raising the bar each time the pupils achieve a formative objective). All of this would be enhanced by a body of exemplars taken from the Scratch online community and tutorials. Additionally, since this was just an introductory course, the course was adapted and taught using Arabic so as to ease the instruction process.

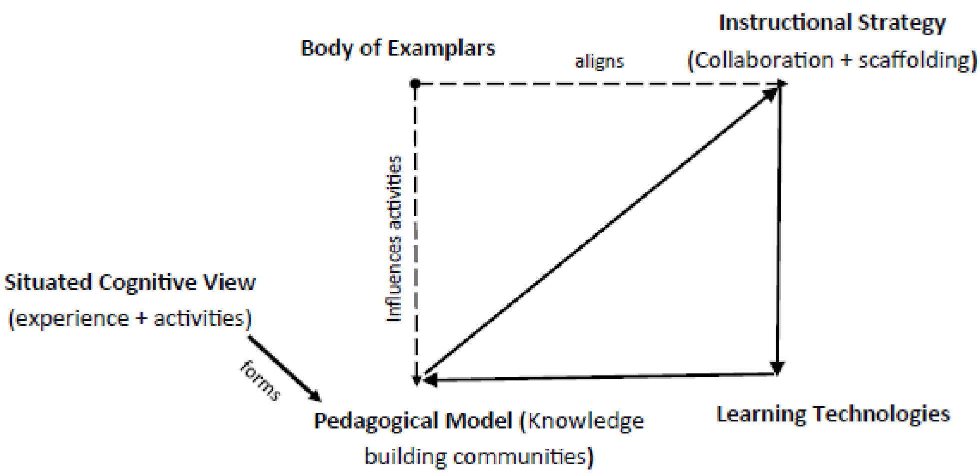

Fig.3. Proposed four-component theory-based design pedagogical framework for e-learning computer programming courses [15]

3. Method

A quantitative survey questionnaire was used to gather 5th and 6th grade teachers' perceptions (202 participants) about the Scratch software and its usefulness. The Statistical Package for Social Sciences (SPSS) was used to analyze the data. In the aim of including only teachers who are concerned with Scratch teaching (that is because Scratch had been introduced in teaching coding in Moroccan schools since the scholar year 2020/2021 [23]), we have opted for purposive homogenous sampling which included only 5th and 6th grade teachers. Evidently, in purposive sampling, the researcher targets specific data and sets out to find people who would provide the information by virtue of knowledge or experience, as cited in [16]. The researchers made sure to administer the questionnaire to 5th and 6th grade teachers only by sending the google form to school principals and asking them to transfer the questionnaire to the targeted participants. Lastly, data was collected from all 12 regions of Morocco.

The questionnaire was translated into Arabic and went through a pilot administration for adjustment purposes. The questionnaire was divided into four sections (including demographics, i.e., the first section). The second section was a yes/no question asking the participant whether s/he taught Scratch or not. If they did, they would be redirected to section three examining their perceptions about the studied software (based on a five-point Likert scale ranging from "strongly agree"=1 to "strongly disagree"=5. In case they did not, they would be redirected to the fourth section examining the reasons behind their inability to use it (multiple checkboxes and "other" box). Table 1 shows the reliability test of the used Likert scale.

Table 1. Cronbach's Alpha reliability test of the Likert scale

Cronbach's Alpha	N of Items
.912	13

Concerning the factors that could have impacted the survey data collection, we mention the factor of time as the survey was out there for two months. We had to deactivate answers' reception on the form as we thought that the sample is representative enough given that only half of the 5th and 6th grades teachers are concerned (i.e., the French teachers who were assigned the scientific activity subject) and that teaching coding has been adopted only in 2020/2021 school year.

Concerning the experimental study, we have opted for random sampling so the two control and experimental groups were randomly divided for the sake of research reliability and validity. In more detail, the pre-test post-test experimental study has involved 38 pupils of the 6th grade in a school located in a rural area in Fes Meknes region. The control group (19 participants) was not taught the basics of scratch coding while the experimental group (19 participants) was taught through practical Scratch coding initiation lessons based on the theory-based model for computer programming teaching. The experimental group was taught during eight weeks, two sessions of one hour per week using a computer and a data show. By the nineth week, both groups were tested by having them perform six different tests on Scratch.

Finally, using both methods had enabled data collection from two different sets of participants (two crucial components of the teaching-learning activity) which had enriched our insights and the results obtained from data analysis. Teachers have helped us unveil their coding teaching views and how it impacted their classes. As for the students, they provided us with many perspectives on how coding is ought to be taught and how beneficial it is in many ways discussed in the results' section.

4. Results and Discussion

For the analysis phase, data was entered into SPSS and analyzed through descriptive statistics. The results are as follows:

4.1. Gender distribution

Table 2. Participants by gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	88	43.6	43.6	43.6
	Male	114	56.4	56.4	100.0
	Total	202	100.0	100.0	

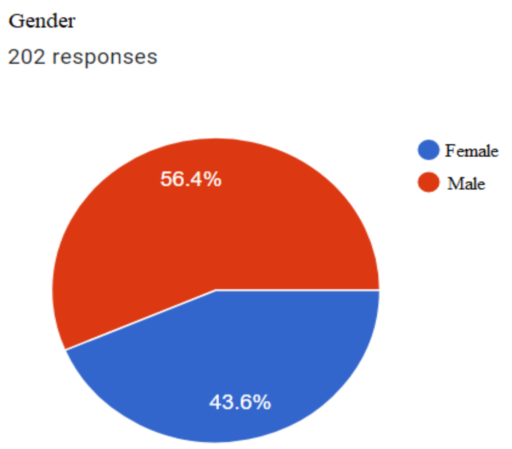

Fig.4. Participants by gender

4.2. Age distribution

Table 3. Participants by age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	23-30	52	25.7	25.7	25.7
	30-37	60	29.7	29.7	55.4
	38-45	53	26.2	26.2	81.7
	45<	37	18.3	18.3	100.0
	Total	202	100.0	100.0	

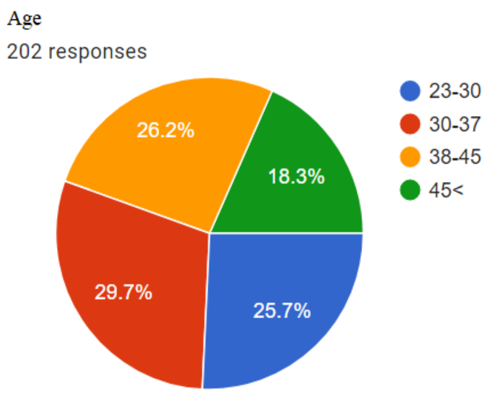

Fig.5. Participants by age

4.3. Experience in teaching

Table 4. Participants by experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	63	31.2	31.2	31.2
	6-10	34	16.8	16.8	48.0
	11-15	29	14.4	14.4	62.4
	15<	76	37.6	37.6	100.0
	Total	202	100.0	100.0	

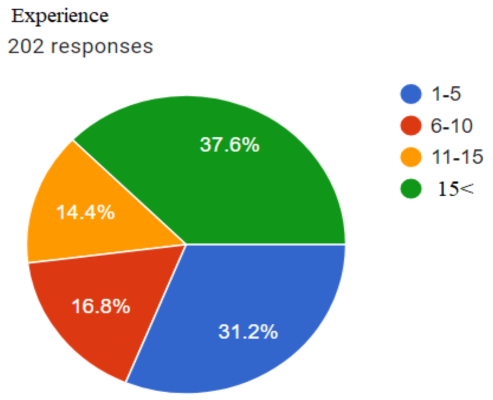

Fig.6. Participants by experience

4.4. Place of work

Table 5. Participants by place of work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Urban	60	29.7	29.7	29.7
	Rural	142	70.3	70.3	100.0
	Total	202	100.0	100.0	

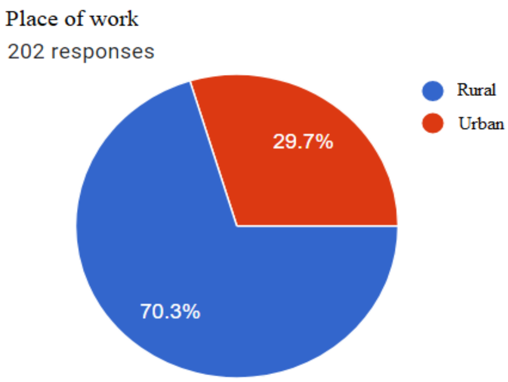

Fig.7. Participants by place of work

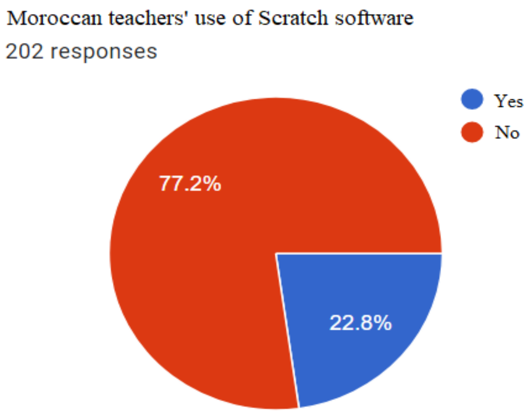

Fig.8. Participants depending on their Scratch use

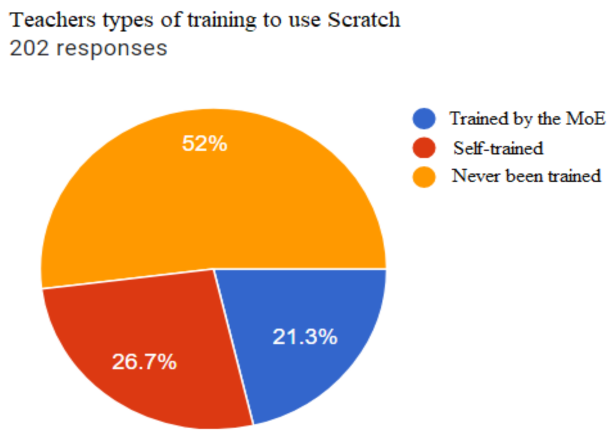

Fig.9. Teacher's types of training received

As can be viewed in Fig. 4 and Table 2, male participants account for 56.4% while female participants account for the rest (i.e., 43.6%). The difference in terms of gender was not that much significant in this study and was due to chance as we cannot control the participants' gender.

Furthermore, as can be captured from data visualization in Fig. 5 and Table 3 concerning age distribution among participants. The three groups 23-30, 30-37, 38-45 scored almost the same percentage (around 27%) except for the 45< category which scored the lowest participation rate of 18.3%. Overall, the percentage difference is negligible and was also due to chance.

Experience distribution among participants, based on Table 4 and Fig. 6, showed a dominant participation of the "15< years of experience" category accounting for 37.6%. The "1-5 years of experience" category comes next with a 31.2% participation rate. Lastly, the "6-10" and "11-15" years of experience scored the least with the respective percentages of 16.8% and 14.4%.

Participants' distribution by place of work, according to Table 5 and Fig. 7, was marked by a dominant participation of teachers working in rural areas. This is, maybe, due to the fact that they are the most dominant category in the actual population.

4.5. Moroccan teachers' perceptions of Scratch

In the aim of exploring Moroccan teachers' perceptions of Scratch, we relied on descriptive statistics. The latter proved that all statements have scored mean scores no less than 3.63 (refer to Table 6). The more so, the median (as well as the mode except for one statement) varied between 5= *strongly agree* and 4= *agree*. Furthermore, the standard deviation scores were low meaning that the data is clustered around the mean. Therefore, the sample, mostly agrees with the statements examined in the below five-point Likert-scale. In practical words, Moroccan pupils, based on their teachers' beliefs, enjoy the activities and steps related to Scratch lessons, show significant improvement learning the software basics, look forward for its sessions, become more confident at using ICT thanks to Scratch, and finally they can successfully use Scratch within the limits of the course by the end of the year.

As far as teachers are concerned, they believe that (1) teaching Scratch is useful in teaching programming in the Moroccan context; (2) that it is preferable to teach Scratch in groups; (3) they would use Scratch to create content for other subjects; (4) feel comfortable teaching Scratch; (5) recommend using it to teach the basics of programming to pupils; (6) and that their colleagues recommend teaching Scratch. Concerning Scratch itself, one of the interesting endorsed statements is the fact that learning Scratch affects the learning of other subjects positively.

Given the fact that Scratch has been recently implemented in the science subject, most teachers (77.2%) reported their inability to teach Scratch (Fig. 8) for various reasons which we have explored in section four of the questionnaire. The main reasons for that were: the fact they were not trained to use it yet (52% were not trained yet, 26.7% were self-trained, and 21.3% were trained by the ministry, see Fig. 9). Other important reasons included the lack of ICT tools at schools (absence of computers, electricity, internet, reported by 99 participant), combined classes (21 participant), its demanding pedagogical tasks (5 participants), time constraints (3 participants).

Table 6. Moroccan teachers' perceptions' means' scores

	Mean	Median	Mode	Std. Deviation
My students enjoy the activities and steps of the Scratch lesson	4.565	5.000	5.0	.6201
Most of my students show significant improvement in learning the basics of Scratch	4.130	4.000	4.0	.8847
My students look forward to their next Scratch class	4.391	4.500	5.0	.7142
Learning Scratch affects the learning of other subjects positively	3.935	4.000	5.0	.9978
My students are more self-reliant thanks to Scratch	3.739	4.000	3.0	.9294
My students become more confident in using ICT thanks to Scratch	4.022	4.000	4.0	.9307
My students can successfully use Scratch within the limits of the course at the end of the year	3.630	4.000	4.0	.9512
Teaching Scratch is useful in teaching programming in the Moroccan context	4.239	4.000	4.0	.8215
It is preferable to teach Scratch in groups	3.913	4.000	4.0	1.0072
I will use Scratch to create content for other subjects	3.913	4.000	4.0	.9387
I feel comfortable teaching Scratch	4.283	4.000	4.0	.7200
I recommend using Scratch to teach the basics of programming	4.391	4.500	5.0	.7142
My colleagues recommend teaching Scratch	4.174	4.000	5.0	.9263

Note. 1= "Strongly disagree"; 2= "Disagree"; 3= "Neutral"; 4= "Agree"; 5= "Strongly agree"

4.6. Experimental study results

The score sheets were adapted from [13] where she studied beginners learned competencies in Scratch 2.0 programming while our study had targeted more simplified competencies in Scratch 3.26.0 because both control and experimental groups showed little computer literacy given the fact that only one pupil had a computer at home.

We also opted for the Moroccan primary school grading system which has a higher mark of 10 (/10). Each achieved competency accounts for one point. Table 7 shows the used grading system along with the adjectival rating. We also calculated the mean percentage score (MPS) for each test and the overall MPS of all the tests.

Table 7. Grading system

Mark	Adjectival rating
10-9=100%-90%	Outstanding
9-8=90%-80%	Excellent
8-7=80%-70%	Very good
7-6=70%-60%	Good
6-5=60%-50%	Fair
5-0=50%-0%	Failed

4.6.1. Pre-test results of the experimental group

Table 8. Pre-test results of the experimental group

Learning Competency	(1) $TotalScore = Samples \times NumberofItems$	MPS	AdjectivalRating
1. **Getting started: 1.** Open scratch 2. Change language 3. Name project 4. Save project 5. Open tutorials	$19 \times 5 = 95$	8.42	Failed
2. **Scratch basic functions:** 1. Change Sprite 2. Change background 3. Change Sprite orientation 4. Paint a new Sprite 5. Dragging blocks	$19 \times 5 = 95$	10.52	Failed
3. **Blocks functions:** 1. Motion 2. Looks 3. Sound 4. Events 5. Control 6. Sensing 7. Operators 8. Variables 9. Pen 10. Music.	$19 \times 10 = 190$	0	Failed
4. **Exercise 1**: 1. Delete existing Sprite 2. Import Sprite called "beetle" 3. Move it 10 steps 4. Say "Hello" 5. Disappear	$19 \times 5 = 95$	0	Failed
5. **Exercise 2**: **Animate a name:** 1. Pick a letter Sprite 2. Play a sound when clicked 3. Pick another letter Sprite 4. Change color 5. Pick a third letter Sprite 6. Make it spin 7. Pick another letter Sprite 8. Make it larger	$19 \times 8 = 152$	0	Failed
6. **Exercise 3**: Make a clicker game: 1. Pick "Balloon 1" Sprite 2. Play sound when clicked 3. Create a score variable 4. When Sprite is clicked increase score by one 5. Go to a random position 6. Change color 7. Reset score 8. Save game.	$19 \times 8 = 152$	0	Failed
Total		**3.15**	**Failed**

4.6.2. Post-test results of the experimental group

Table 9. Post-test results of the experimental group

Learning Competency	(2) $TotalScore = Samples \times NumberofItems$	MPS	Adjectival Rating
1. Getting started: 1. Open scratch 2. Change language 3. Name project 4. Save project 5. Open tutorials	$19 \times 5 = 95$	98.94	Outstanding
2. **Scratch basic functions:** 1. Change Sprite 2. Change background 3. Change Sprite orientation 4. Paint a new Sprite 5. Dragging blocks	$19 \times 5 = 95$	100	Outstanding
3. **Blocks functions:** 1. Motion 2. Looks 3. Sound 4. Events 5. Control 6. Sensing 7. Operators 8. Variables 9. Pen 10. Music.	$19 \times 10 = 190$	88.42	Excellent
4. **Exercise 1**: 1. Delete existing Sprite 2. Import Sprite called "beetle" 3. Move it 10 steps 4. Say "Hello" 5. Disappear	$19 \times 5 = 95$	96.68	Outstanding
5. **Exercise 2**: **Animate a name:** 1. Pick a letter Sprite 2. Play a sound when clicked 3. Pick another letter Sprite 4. Change color 5. Pick a third letter Sprite 6. Make it spin 7. Pick another letter Sprite 8. Make it larger	$19 \times 8 = 152$	84.86	Excellent
6. **Exercise 3**: **Make a clicker game:** 1. Pick "Balloon 1" Sprite 2. Play sound when clicked 3. Create a score variable 4. When Sprite is clicked increase score by one 5. Go to a random position 6. Change color 7. Reset score 8. Save game.	$19 \times 8 = 152$	100	Outstanding
Total		**94.32**	**Outstanding**

Table 10. Experimental test overall results

	1st test	2nd test	3rd test	4th test	5th test	6th test
Total	94	95	168	89	129	152
Median	5	5	9	5	7	8
Standard Deviation	0.23	0.00	0.60	0.48	0.85	0.00
Mean	4.95	5.00	8.84	4.68	6.79	8.00
MPS	98.9474	100	88.4211	93.6842	84.8684	100

As can be inferred from Table 8, Table 9 and Table 10, both experimental and control groups have failed the pre-test. The control failed the post-test, as well, with a rating of less than 10% (failed). However, the experimental group showed outstanding coding skills within the scope of the study with a total MPS of 94.32% (outstanding). The study results align with many other studies especially the ones of [17, 18,19, 20, 21, 22, 23, 24, 25].

Furthermore, the mean score and median, according to Table 10, are always close the highest score in every test making the standard deviation small meaning that the data is clustered around the mean. All of this shows that Moroccan pupils can code in the right context and with the correct instruction.

All in all, the studied students' sample was able to effectively manipulate the sprite, differentiate between the blocks' functions, animate a sprite and even make a game following precise instruction by the end of the course. And although creativity was not the target measurement in our study, but our students showed the ability to go beyond the course objectives and create personal projects on their own as witnessed in the experiment where [17] found that the problem-based digital making environment supported the students' development of critical thinking, creativity, and communication.

Also, [18] experiment is somewhat relevant to our study, [18] proved that both construct-by-self mind mapping and construct-on-scaffold mind mapping can improve students' computational thinking skills. We, on the other hand, noticed great difference between the control and experimental groups as the latter showed increased computational thinking. It makes sense because the control group, as mentioned at the beginning of the experiment, had no computational thinking at all.

Another possible aspect that we could have addressed was the gender differences in coding learning as we have reviewed in [20] where they studied possible biases based on gender, learning perception, usage and students' personalities between three experimental conditions: three groups using Scratch, App Inventor and Alice 3D respectively. The outcome showed different gender preferences for the three programming tools and, in some cases, different emotional effects on the students.

5. Conclusion

The present paper is tangible proof that even in rural areas where there are limited ICT tools, pupils could overcome their ICT illiteracy and become handy at using computers and go as far as to code within the limits of the course. Furthermore, thanks to the Genie program, school units have been provided with a computer, a data show, and loud speakers which made the study feasible. Nevertheless, taking turns at using one computer did take a great deal of time especially during the tests which was one of the study limitations. Another limitation was the fact that some pupils had never touched a computer before. However, as soon as they practiced for the first time, they started mastering it as the practical lessons increased in number.

We, therefore, urge teachers, the MEE, and educational stakeholder to boost ICT integration even more. And, we dare to say that the chalk and talk instruction is not suitable to and does not interest the digital native generations anymore. Using ICT could enhance learning productivity in both regular and pandemic times. That said, the learned content should be fun and attractive for it to compete with online games and videos to which these generations are addicted to.

Finally, the fact that Moroccan pupils have showed the ability to code with Scratch in a relatively small period of time while their teachers endorsed teaching the same software are two interesting outcomes because frankly when we started the study, we did not expect such success. That is because the software is newly adopted and many teachers had no idea how to use it. So, we recommend that the MME accelerates Scratch trainings for teachers because it was the main reason behind their inability to use it. For future studies, we hope to read about the impact of Scratch on other subjects especially on STEM subjects and critical thinking in some paper in the near future.

All in all, Scratch proved to be a useful teaching aid in teaching coding to kids in the Moroccan context. In fact, Scratch increased pupils' motivation to learn coding, increased their confidence-level, made coding enjoyable, facilitated coding learning, and influenced other subjects' learning positively. On the other hand, Scratch is viewed, by teachers, as a comfortable tool through which they went so far as to create course material for other subjects.

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