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Visual Block-based Programming for ICT Training of Prospective Teachers in Morocco

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Abstract: We conducted a training experimentation on computer coding whose aim is to probe ICT skills enhancement of pre-service teachers in Morocco. For that, we have developed and implemented training sessions using a visual programming tool (Scratch) targeting 63 prospective teachers at the Faculty of Educational Sciences (FSE) and the Regional Center for Education and Training Professions (CRMEF) in Nador, Morocco. During these sessions, trainees were introduced to algorithmic thinking where they implemented teaching sequences in their specialty subjects using Scratch. Pre and post surveys were conducted to measure the evolution of the trainees' perceptions towards the integration of computer coding in the teaching and learning of their specialties. The analysis of the surveys showed the potential of integrating computer coding in the development of learners' transversal skills. The training revealed different possibilities of exploiting visual block-based programming environments in the teaching and learning process.

Index Terms: ICT, Teacher Training, Computer Science in Morocco, Informatics teaching, block-based programming environments, Scratch.

1. Introduction

New digital technologies and ICT has become essential in today's society [1,2], and Computer Science (CS) as a school subject is becoming increasingly important in educational curricula [3, 4, 5, 6]. In particular, reform's calls of CS education's curricula agree to teach programming and algorithmic thinking from primary school [6, 7, 8, 9]. Indeed, informatics education as a science allows learners to develop high-level transversal skills such as communication, sharing, critical thinking, problem solving, autonomy, creativity ... [10]. In addition, CS has the capacity to integrate into various fields: Mathematics, Earth and Life Science, Physical and Chemical Sciences, Medicine, Engineering, Educational Sciences, Literary Studies, Law ... [11].

The increasing interest given to CS education and more specifically computational thinking and programming from elementary school, both nationally and internationally, is at the origin of our questioning: "How can we enhance computer coding education in Morocco?". Indeed, a major challenge for CS education and in particular at the primary level is to have a large number of teachers trained in CS and how to integrate ICT in courses. In order to promote CS education in Morocco, and in particular to develop learners algorithmic thinking, it is important to provide in-service and pre-service teachers fundamental knowledge in CS and ways to integrate it in their teaching. In this article, we provide an overview of CS education in elementary and secondary schools in Morocco. We also report introductory activities in algorithmic thinking and visual block-based scratch programming [12] conducted with 63 pre-service teachers from FSE and CRMEF. These sessions have been integrated into ICT training modules. A questionnaire was conducted to measure the evolution of students' perceptions towards the integration of computer coding in the teaching / learning of subjects they will teach. The comparative study of the evolution of students' perceptions showed an increasing awareness of the potential of computer coding in the teaching and learning processes and in the development of algorithmic thinking as well as learners' transversal skills.

2. Computer Science Education in Morocco

Before providing an overview on CS education in Moroccan school system, we highlight that in most CS education curricula around the world, we can distinguish between informatics as a tool and the informatics as a science [6]:

- informatics as a tool: consists of the use of digital technologies ranging from "Digital literacy" to "Digital fluency".
- informatics as a science: it concerns the identification of the principles of operations and computer system design, problem solving and algorithmic thinking.

Morocco undertook CS education integration tests back in the 1980s. Morocco then developed a training charter which constitutes the framework of orientations and educational philosophy in 1999, in order to rethink the integration of informatics as a generalized subject in the Moroccan education system [13]. Fig. 1. illustrates the timeline of CS education in Morocco.

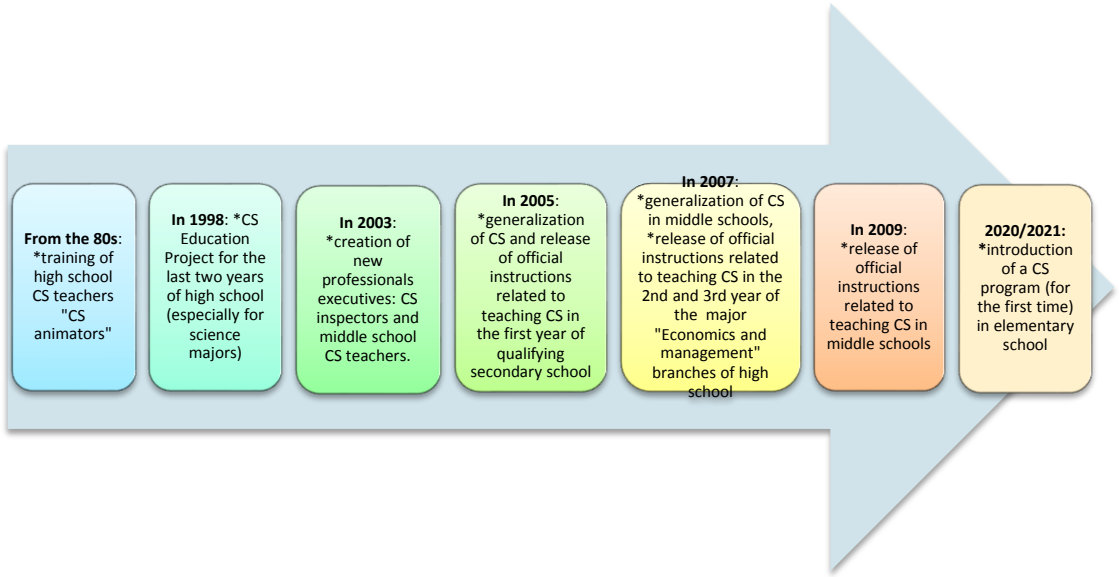

Fig.1. Timeline of CS education in Morocco

A. Computer science education in primary schools

During the academic year 2020-2021 the Ministry of National Education, Vocational Training, Higher Education and Scientific Research (MEN) has introduced for the first time a CS curriculum mainly based on coding [14]. This program was integrated in the school subject "Science Awareness (Attafatuh Al-Elmi)" and was presented in the form of activities based on software manipulation and/or visual block-based programming with Scratch in the 5th and 6th grades programmed for one hour per teaching unit (Table 1)

Table 1. CS curriculum in elementary school [14]

	Elementary school: 5th grade		**Elementary school: 6th grade**	
Unit	**Topics**	**Objectives**	**Topics**	**Objectives**
1	**Coding introduction using Scratch**	Presentation of scratch as a programming and creation tool. Presentation of the different icons of the interface of Scratch software.	**The characters**	Choose and customize characters (character library, import from file, design a character).
2	**The Scratch software interface**	Handle Scratch interface, know the sprite library, import from a file, design a sprite ...	**Instruction blocks**	Be familiar with some instruction blocks (Motion, Looks, Event, Control, Sound, Operators, Pen, Data, Sensing, More blocks)
3	**The background**	Choose and customize the background of the scene (background library, import from a file, design a background).	**Instruction blocks - 2**	Be familiar with some instruction blocks (Sound, Operators, Pen, Data, Sensing, More blocks)
4	**Software manipulation -1**	Handling a drawing software (freehand drawing, drawing some geometric shape...).	**Controlling characters**	Make the character talking

5	**Software manipulation -2**	Use word processing software (enter text, save a file, etc.).	**Controlling characters - 2**	Move the character to the right. Move the character up.
6	**Software manipulation -3**	Handling a search engine, recording information (text, images, videos).	**Customize the scene**	Customize the decoration. Change the scenery according to character's actions.

In the Moroccan private education sector, we can highlight better implementation of CS education. The adopted textbooks offer introductory activities in the use of informatics as a tool and may also include fun activities related to programming and algorithmic thinking [15].

B. Computer science education in secondary schools

1. Computer science in middle schools:

CS was programmed in the middle school curricula since 2007. It aims at having students use ICTs to search, process and communicate information. Starting the 2nd year, students are introduced to algorithmic thinking, programming and problem-solving [16].

2. Computer science education in High Schools:

CS as a school subject has been taught in the first year of high school since 2005. The adopted curriculum focuses on the use of ICT tools as well as an introduction to algorithmics and programming [13]. For the major "economic, management and accounting science" the focus is on MS office, internet services, and ICT tools in management and accounting [17, 18].

C. ICT in teacher training institutes:

Training modules at CRMEF [19], which were updated in 2014, include informatics as a tool through ICT module, algorithmic thinking, and programming concepts are only covered in specialized scientific and technical fields. The intended learning outcomes of the ICT module is the ability to:

- work in a digital environment
- produce, process, use and share digital documents
- use ICT for self-learning
- communicate and exchange data using ICT
- select and integrate digital resources
- manage a session integrating digital resources
- …

We notice that informatics is only used as a tool while the basics of CS are almost absent in ICT teachers' training curricula. Thus, it is important to provide in-service and pre-service teachers an adequate training of the fundamentals of algorithmic thinking and coding in order to promote CS education.

D. Computer coding experiences in training and education related institutions

Although customizing and creating programs requires advanced CS skills [20], there are some programming environments that make programming easier for beginners through the creation of games, animations and stories. In this context, several studies have proven the effectiveness of these environments (Scratch environment in particular) in teaching basic programming concepts and in parallel enhancing pupils' transversal skills such as communication, sharing, algorithmic thinking, problem solving, autonomy, and creativity [10]. Scratch environment has proven its effectiveness even at a university level. Several studies [21,22,23,24,25] focused on studying pre-service teachers attitudes after their exposure to awareness sessions on computer coding. Table 2 presents a summary of published results on the subject. These studies clearly demonstrate the positive effect of sensitizing pre-service teachers to computer coding on their perceptions on CS education, and in enhancing their ICT capacities.

Table 2. Research work on studying pre-service teachers attitudes on computer coding

Authors(s)	Purpose of the study	Results of the experiment
Daher et al. [21]	Study the impact of using problem solving and negotiation on the development of pre-service teachers' meta-cognitive skills in solving mathematics-based programming problems. The experiment was carried out with 18 prospective mathematics teachers. Scratch environment is used during practical training as a tool for drawing geometric shapes or doing algebraic operations	The research results show that problem solving and negotiation processes, supported pre-service teachers not only in learning coding but also in the development of their meta-cognitive processes in solving mathematics-based programming problems with Scratch.

Papadakis et al. [22]	Promote the teaching of computational thinking and coding in preschool. To do this, for 13 weeks, 120 pre-service kindergarten teachers were introduced to visual block-based programming with Scratch and were asked to develop an educational game.	Results show that the performance of Pre-service kindergarten teachers in computer coding has improved considerably and that participants are aware of the educational potential of teaching computational thinking and coding in preschool
Romero et al. [23]	Introduce 51 pre-service teachers to the different ways of integrating games into the elementary school.	The results revealed that before the experiment participants were unaware of the possibilities to reuse existing programs or create new ones using visual block-based programming environment.
Kim et al. [24]	Improve the ICT capacities of Korean teachers.	At the end of the experiment, the pre-service teachers developed programming skills in an implicit way and they strengthened their ICT capacities in order to innovate and integrate these new technologies into their teaching practices.
Baron et al. [25]	introduce educational science students to programming using the Scratch environment, as part of a project-based pedagogy.	The results showed that it is possible to have relatively interesting programs produced by people not previously trained in CS.

3. Experiment

In order to provide answers to our research question which concerns awareness, and students' perception study of education and training related institutions on computer coding, we followed an experimental plan based on fun ludic activities.

A. Objectives

- Enriching pre-service teachers' ICT experience.
- Introducing algorithmic approach for the design of educational activities in other subjects.
- Increasing awareness about the importance of computer programming and coding in education

B. Tool used: Scratch environment

Scratch is a visual block-based programming environment known for its educational and entertaining vocation, it has a very large library of programs ready to use and modify. Scratch community is very large and active, it has more than 65 million registered users and more than 69 million shared projects[1]. Several researchers have recommended the use of block-based visual programming environments to develop higher education institutions students' algorithmic thinking and programming skills [26, 27, 28], which makes Scratch an optimal environment for our context.

C. Sample of the study

We conducted the experiment with three different groups of pre-service teachers belonging to two different institutions. Each group has a different specialty. The total number of participants is 63. Table 3 shows the distribution of participants in our experiment.

Table 3. Experimental Group Composition

Group	Composition	Teacher Training Institutes
A	15 students in professional license in "Musical Education and Animation of Musical Structures" (LPEMASM).	Faculty of Educational Sciences
B	24 pre-service teachers of primary education, option "Amazigh language"	Oriental CRMEF, Nador annex
C	24 pre-service teachers of primary education, option "bilingual"	Oriental CRMEF, Nador annex

D. Upstream of the experiment

First, we emphasized skills prescribed in the descriptions of the ICT module relating to our sample. Then we developed educational sequences related to these skills, based on the practice and the creation of educational program using Scratch environment. The educational scenarios take into account the nature and specificities of the training courses of the participants.

E. Conduct of the experiment

The experiment was carried out during 3 sessions, at the FSE for group A, and at Oriental CRMEF, annex Nador for groups B and C:

[1] https://scratch.mit.edu/statistics/, WEB page consulted on January 26, 2021

A pre-survey was administered to all participants prior to the experiment whose goal was to identify their level in CS and their general opinion about the subject. The participants were then introduced to algorithmics and programming using fun educational activities like Blockly mazes[2] and other resources available on code.org. In the following session, the participants were introduced to the Scratch programming environment and they were invited to create animations and simple games using available tips from the software menu. During the last session, the participants created programs related to the disciplines they will be teaching. Pre-service teachers from the CRMEF created alphabet labyrinths (Fig. 2) and stories and dialogues in different languages (Arabic, French, and Amazigh) (Fig. 3.). Participants from the LPEMASM created simple educational musical programs by exploiting different commands in the sound blocks of Scratch (Fig. 4). All participants were also invited to consult the various online resources shared by the very active worldwide community of Scratch.

At the end of the last session, participants produced educational class scenarios that integrate the developed Scratch resource in accordance with the official instructions of teaching their subjects.

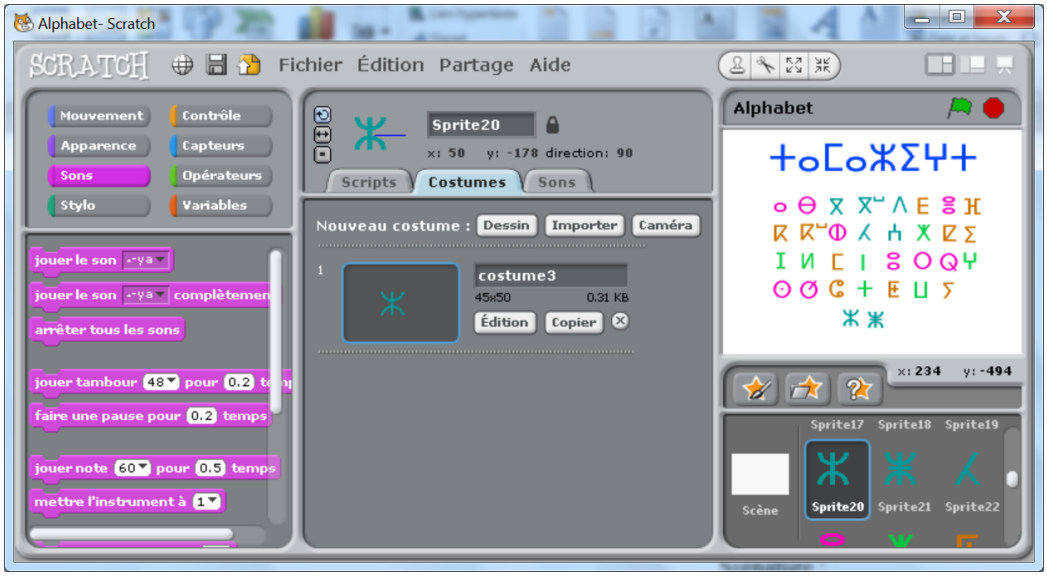

Fig. 2. Amazigh alphabet sample program with Scratch

Fig. 3. Arabic dialogue example with Scratch

[2] https://blockly-games.appspot.com, WEB page consulted on January 26, 2021

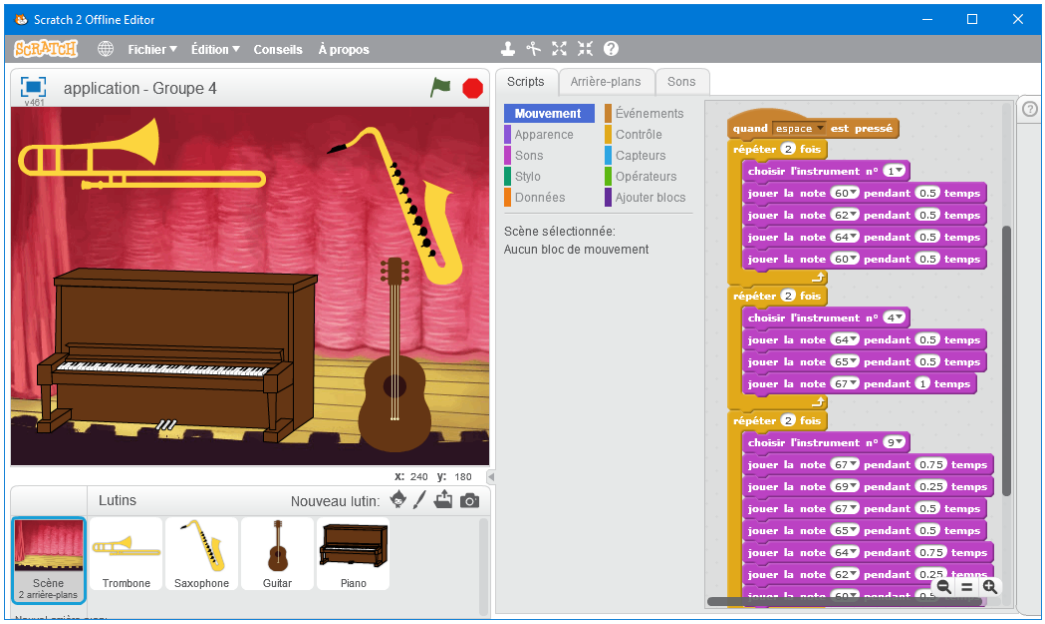

Fig. 4. Musical sample program with Scratch

4. Results and Discussion

A. Participants experience with the CS subject

56 students participating in our survey (among 63) followed informatics courses for at least one year during their schooling (1 student took informatics courses in elementary school, 26 took these courses in middle school, 23 in high school and 16 during their higher education).

78 percent of these students say that they have acquired the basics concepts of word processing software and consider that the informatics courses they have taken have helped them to develop manipulation skills of spreadsheet and presentation software. However, more than half of participants who followed informatics courses seem to be unsatisfied with their knowledge relating to the creation of computer programs, production of multimedia documents, creation of Web pages and Internet services. In addition, most of them find computer courses boring and not interesting.

When participants were asked about their experience with algorithms and programming: 53 participants said they did not know the meaning of the term "algorithm" but 20 students reported that they have attended a programming course during their schooling.

These results corroborate those obtained during a similar study with middle and high school students that a significant rate of learners experience negative attitudes about their knowledge report to informatics, in particular programming, production of multimedia documents and the creation of WEB pages [6,29].

B. Evolution study of participants' perception on computer coding

The results study of the evolution of participants' perception on computer coding as object of teaching in Morocco are summarized in the following table:

Table 4. Evolution study of participants' perception on computer coding (N=63)
*Acc_Av et Acc_Ap represent respectively the number of students who expressed an agreement before and after the experiment
* the rate T represents the absolute value of the difference (Acc_Av - Acc_Ap)/N

Questions	Before (*Acc_Av)	After (*Acc_Ap)	*T
I think that teaching programming in class could:			
• help students develop their imaginations	45	62	27%
• help students learn to cooperate with others	34	59	40%
• improve the capacity of problem solving among students	33	59	37%
• develop communication skills among students	8	56	81%
• motivate students to learn the discipline that I will teach	3	63	95%
• help students, in general, in their learning	6	60	86%

I think I can teach an introduction of computer coding in elementary or middle school	6	45	62%
Currently, I think that teaching programming in elementary school is a priority	6	45	62%
You must have advanced computer skills to introduce students to programming in elementary or secondary school.	62	2	95%

According to the comparative reading of the above data, it appears that the students, once introduced to algorithmic thinking and to visual programming with Scratch, have completely changed their attitudes towards the implicit integration of programming in teaching / learning and in particular in the discipline that they will teach. Indeed, the number of favorable opinions for the proposal "teaching programming in classroom could motivate students to learn the discipline that I will teach" has evolved from 3 upstream of the experiment to 63 (a rate of 95%), and the number of those who are in favor of the proposition "teaching programming in classroom could help students, in general, in their learning" had increased from 6 to 60 (a rate of 86%).

In fact, student's perception on potential of coding in the development of transversal skills in learners has improved positively, indeed, after the experiment, the number of participants who believe that the integration of computer coding in classroom could develop the imagination of the pupils has increased from 45 to 62 (a rate of 27%). Those who believe that computer coding can help develop collaborative and problem-solving skills among learners has evolved to 59 with an average rate of 38.5%. Regarding the proposal "teaching programming in classroom could develop communication skills among students", the improvement is very significant (T = 81%), the number of favorable responses had increased from 8 to 56.

The analysis of the results also shows an improvement in participants' personal sense of efficacy [30] in teaching the introduction of computer coding in elementary or middle school (T = 62%), in this sense, almost all students consider that it is not necessary to have advanced computer skills to introduce pupils to programming in elementary or secondary school.

On the other hand, the number of those who consider teaching programming at elementary school a priority has increased from 6 to 45 with a rate of 62%, which shows that around 72% of the participants are convinced of the importance of introducing computer coding from elementary school.

We can conclude that the conducted training sessions gave the opportunity to trainees who participated in our experiment to appreciate the positive contribution that can bring the integration of computer coding with Scratch environment in teaching and they were able to grasp the educational potential of this environment and in particular in the teaching / learning of the discipline they are going to teach. In the end, these participants recommended the integration of block-based programming activities into the training of students of training and education related institutions. These results corroborate data from similar studies on the integration of ICT in training prospective teachers [21, 22, 23, 24, 25, 31].

5. Conclusion

Most of pre-service teachers who participated in our experiment were doubting the educational potential and aspects of the positive impact of the introduction of computer coding in schools and in particular in integrating it to teaching of various. However, once initiated, their perception changed considerably. Participants appreciated Scratch environment and seized its educational potential. Indeed, downstream of the experiment, the majority of participants became favorable for the role of computer coding in the development of learners' transversal skills. They recommended the integration of visual block-based programming environment in the curricula of teachers training institutes.

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