Influence of the Familiarization with "Scratch" on Future Teachers' Opinions and Attitudes about Programming and ICT in Education

Georgios Fesakis
LTEE Lab, University of the Aegean
Dimokratias 1, 85100
Rhodes, Greece
+30 22410 99151
gfesakis@rhodes.aegean.gr

Kiriaki Serafeim
LTEE Lab, University of the Aegean
Dimokratias 1, 85100
Rhodes, Greece
+30 22410 99151
pse04178@rhodes.aegean.gr

ABSTRACT
Computer programming is considered a very important competence which is usually quite difficult to learn. Teaching computer programming to novices has to overcome important obstacles in order to be successful. The problem is even greater for non computer science majors. In order to overcome the difficulties and increase the rate of students that adopt positive views towards computer science, several educational programming environments have been proposed. Scratch educational programming environment offers innovative programming techniques and enables the rather easy development of games, animations, interactive stories etc. In this paper the effects of using Scratch in an introductory computer programming course for future teachers' attitudes and opinions are explored.

Categories and Subject Descriptors
K.3.0 [**Computers and Education**]: Non-majors, opinions and attitudes towards computer programming and ICT in Education

General Terms
Human Factors, Languages

Keywords
Scratch, non-majors, attitudes

1. INTRODUCTION
Computer programming is considered in general an important competence. The educational interest of computer programming stems not only from its economic importance but also from its value as a learning environment. Computer programming constitutes a key skill for the comprehension of many other areas of Computer Science. Furthermore, some specific computer programming systems could be considered as constructivism compatible, general purpose, learning environments [15]. Computer programming can be exploited for the development of higher order skills like: problem solving, creative thinking, logical reasoning, systematic experimentation, etc. In addition, recently computer programming has been referred to as literacy for modern society because it enables citizens to become active producers of interactive digital content for web 2.0 [12,17].

For the above and other reasons computer programming has been introduced in many curriculums of all grades. Computer programming is offered even to non-majors in higher education programs that are not straightforward related to computer science. Among these non-majors, future teachers often get computer programming familiarization either for immediate educational use or in order to be able to produce interactive, multimedia, learning content.

Despite its importance, computer programming competence is considered to be difficult to develop [16, 20]. Students often face difficulties in the comprehension of central concepts [3, 8] and in composing programs that fulfill certain specifications. It is characteristic that the rates of students that fail or drop out in introductory computer programming courses are estimated to (15-30) % [6].

Various approaches have been proposed in order to increase the attendance and soften the difficulties of novice computer programming learning such as: the development of educational programming languages [3] that make programming more attractive to learn [5], the computer programming didactics research [20], and the study of environments for informal computer programming learning [9].

In this paper we focus on the effect of the familiarization with the Scratch educational programming environment on the opinions of future teachers for computer programming and the use of Information and Communication Technologies (ICT) in education. In the rest of the paper first the Scratch environment is presented briefly, then the research conditions are described, next the research data analysis, and finally the discussion of the main findings and future work are discussed.

2. ABOUT THE SCRATCH ENVIRONMENT
Scratch [11] is an educational programming environment developed by the homonymous project of MIT Media Lab [10]. Scratch provides graphic programming language making computer programming accessible to children (from 8 years old), adolescents and other novice programmers. Basic control

ITiCSE'09, July 6–9, 2009, Paris, France.

structures (sequential, selection, repetition) are composed by dragging and stacking corresponding graphic building blocks, eliminating the usual syntactical errors. In addition to the basic control structures the language offers event triggers (when-clicked, when-key-pressed) for event driven programming and named broadcasts for multithreading. Using Scratch novice programmers have also opportunities to get familiarized with concepts such as variables, lists-arrays, Boolean logic, user interface design etc. Scratch offers the possibility of constructing media-rich projects that incorporate graphics, animation, music and sound. It also gives the opportunity to create video games, animation, interactive stories etc. Scratch has been used in formal education with structured learning activities (in subjects such as the introduction to computer science [21] or advanced issues in software engineering [18]) as well as in informal learning environments (such as computer clubs [9, 17] etc).

There are several programming environments designed for novice programmers [3, 5, 9]. Scratch has been selected not only because it assembles a lot of positive characteristics as educational programming environment but also because it is accompanied by a live community of users. The members of Scratch community learn computer programming collaboratively, contributing to the community mainly for entertainment purposes. The transformation of the laborious work of computer programming learning into entertainment has legitimate educational interest.

3. ATTITUDES AND OPINIONS OF FUTURE TEACHERS ABOUT ICT

The term "attitude" means the general assessment or feeling of favorable or unfavorable disposal of a person against ICT or specific activities using ICT [14]. The term "opinions" concerns the account of a person for the probability of a statement to be true. In this manner "attitudes" concern the relation of people to the ICT while "opinions" their general convictions about them. According to the Theory of Reasoned Action (TRA) [1], opinions and attitudes determine human behavior in a large extent.

The study of teacher attitudes towards ICT internationally shows that they relate to several factors like [7]: 1. Anxiety & stress, 2. Self-efficacy, 3. Desire and pleasure, 4. Perceptions about ICT value and usefulness etc. Studies also claim that there are differences in attitudes dependent on parameters such sex, education stage, teachers' training etc. Effective teachers' training is considered among the most important factors for the formulation of positive attitude towards ICT [22]. In the special case of future teachers, research [19] claims that women students have higher anxiety and stress levels than men and that the participation in relevant courses helps them lower down the stress levels.

In this direction, our work concerns the design and test of an intervention using Scratch for the formulation of more positive attitudes by students of the department of preschool education and educational design at the University of the Aegean in Greece. Usually most of these students are females, with rather low technological profile. According to the above mentioned research this target group has a higher probability of developing negative attitudes against ICT. The tested intervention has the form of a semester course regarding the development of multimedia educational applications using Scratch as an educational programming environment.

4. RESEARCH

The goal of the research is to study the effects of familiarization with Scratch on the opinions and attitudes of future teachers against ICT and computer programming. The subjects for the research are students of the preschool education and educational design at the University of the Aegean (who were) attending a mandatory course, involving the development of multimedia learning applications. Scratch was the educational programming environment selected for the course. The number of students participating in the research activities varied. Data about the age distribution of students are summarized in table 1.

Table 1. Age distribution of the sample subjects

Birth	f	%	Sex	f	%
<1986	6	17.3	Female	35	100
1987	16	45.7	Male	0	0
1988	11	31.4	TOTAL	35	100
1989	2	5.7			
TOTAL	35	100			

For the collection of research data the following tools has been used:

- A questionnaire for the outline of the students' relation to ICT in the beginning of the course. Using this initial questionnaire we can estimate what students know about and what they are using ICTs for, including programming.
- A questionnaire for the assessment of Scratch and the study of students' opinions about Scratch.
- Two questionnaires for the investigation of the students attitudes against computer programming and ICT in education before and after the familiarization correspondingly.

The research has been implemented during the summer semester of 2008. In the beginning, the questionnaire for the estimation of students ICT skills and the questionnaire for students attitudes had been completed. Then (2^{nd}-4^{th} weeks) Scratch were introduced to students using hands on laboratory activities. Next (5^{th}-8^{th} weeks) students had to design and develop their own projects with Scratch. During this period a forum help-desk was available for students in addition to the usual course sessions. At the end of the semester students completed the questionnaire for the Scratch assessment and the second questionnaire about their attitudes investigation.

4.1 Research Data

In this section the main research results for each research question are summarized.

A. Investigation of the students' relation to ICT's. What students know about and what they are doing with ICT's?

Questions in this section aim to record students abilities and needs in the beginning of the course. The answers of students are summarized in diagram 1. Diagram 1 depicts the uses of ICT by students in decreasing frequency order. Most students use ICT for reproduction of music, document processing, video reproduction, compilation of electronic presentations and games. However the percentage of students that use advanced applications e.g. image, video, sound processing, and/or programming is rather small.

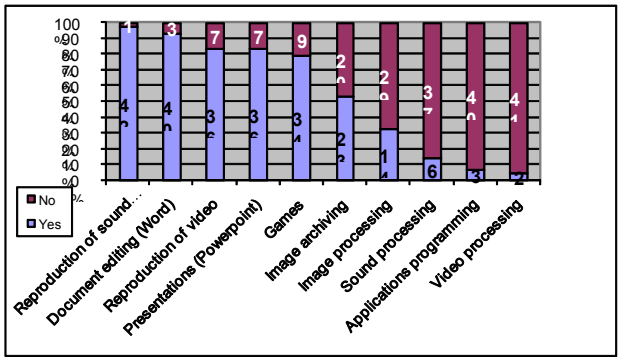

Diagram 1. Everyday ICT uses by students.

B. Students opinions about Scratch

At the end of the course, after their familiarization with Scratch and the projects implementation students were asked about their opinions about Scratch. According to diagram 2, 65% of the sample students believe that Scratch is easy to use. 85% states that the users interface use a simple and understandable language. In addition 80% state that the interface is aesthetically designed. Finally 80% believe that the available features of the environment are satisfactory.

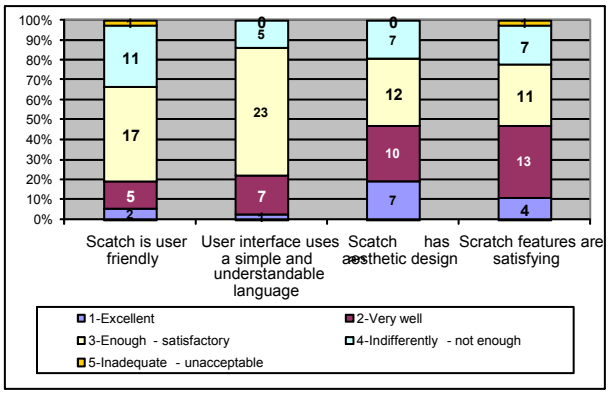

Diagram 2. Scratch general assessment

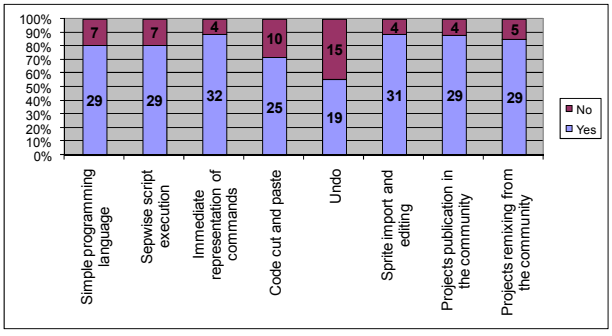

Diagram 3. Assessment of specific features of Scratch

According to diagram 3, 80% of the students consider Scratch as a rather simple programming language, the same percentage of students find the stepwise execution of programs useful. 90% of students find the graphical representation of commands useful and the tasks of importing and processing of objects easy. Furthermore the same percentage considers the publication of Scratch projects in the online community as well as the application remix important.

C. Effect of students' familiarization with Scratch on their attitudes towards the use of ICT in education.

In this section, the students' answers variation in a set of questions about the utilization of ICT and the Internet in education as well as for the development of educational applications, is described

C1. Attitudes against ICT in general

From diagram 4 we see that 80% of students declare that the use of ICT in education is interesting. After their familiarization with Scratch (diagram 5) this percentage increases to 92%.

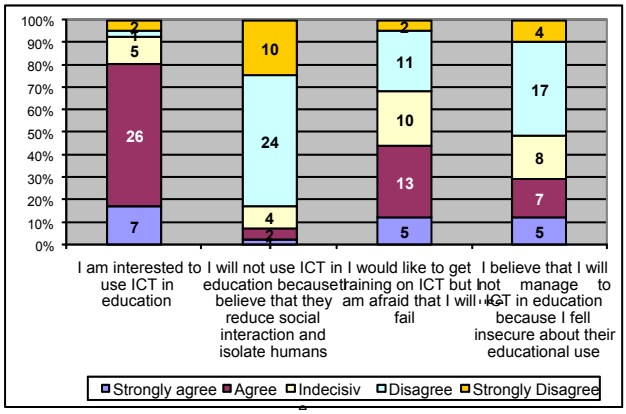

Diagram 4. ICT as an educational tool, initial questionnaire.

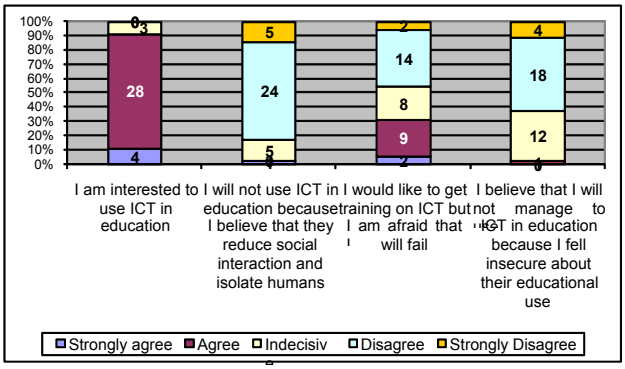

Diagram 5. ICT as an educational tool, final questionnaire.

There is no variation in the second question of the diagram since the percentage of students that do not believe that ICT isolate humans remains at 82%. There is no variation also in students number that wish to get training on ICT as well as to students that believe that they can successfully exploit ICT in education. In the initial questionnaire 50% of students declare that they feel insecure about the possibility of ICT utilization in educational practice. This percentage is decreasing to 35% in the final questionnaire. This variation is the only statistically significant according to X^2 test (X^2=0.917, df=4, p=0.042) despite the fact that there is a positive variation in most of the questions.

C2. Attitudes against internet in education and application development

This section presents the variation of students' opinions about ICT and internet exploitation in education as well as the application development (computer programming) by students.

According to diagrams 6 (initial) and 7 (final) 70% percent of the sample declares that they could utilize internet access of their classroom for instruction and learning.

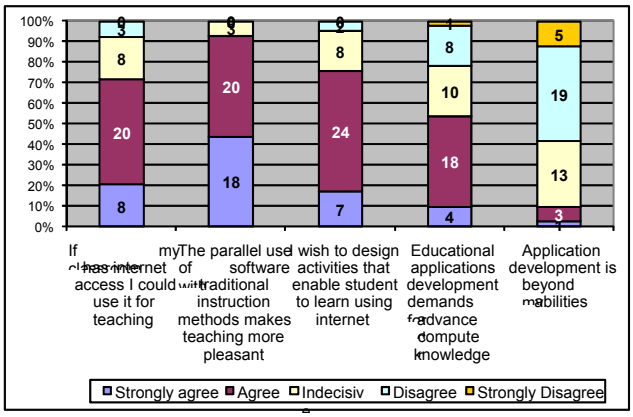

Diagram 6. Internet and application development, initial questionnaire.

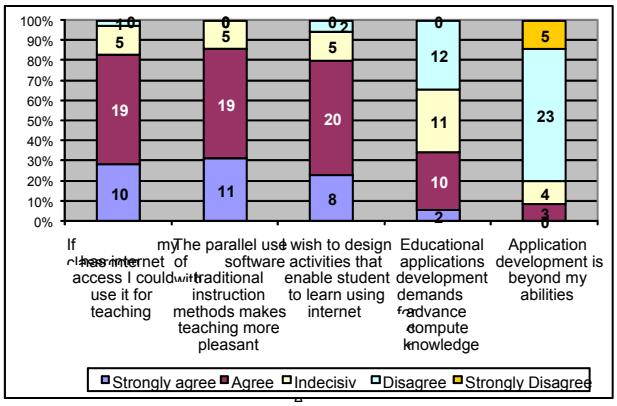

Diagram 7. Internet and application development, final questionnaire.

This percentage increases to 80% in the final questionnaire. In the second question initially over 90% of the students believe that the parallel use of traditional methods with software makes instruction more pleasant. This percentage decreases to 80% in the final questionnaire. 75% of the students wish to develop learning activities that permit to the students to use internet. In the final questionnaire this percentage is 80%. In the question of whether the development of educational application demands advanced computer knowledge, 55% of students initially agree while in the final questionnaire this percentage decreases to 35%. There is also a positive variation in the last question where students declare whether they have the ability to develop applications.

Summarizing the above we can claim that after the familiarization with Scratch students show increased self confidence in exploitation of ICT in education. There are more students that do not declare anxiety and stress about their ability to use ICT as well as students that wish to develop their own educational software applications. This evidence, in relation to other research [20, 22] that notify the importance of success and positive attitudes in introduction courses about computer science support the desirability of the Scratch selection as an educational programming environment for non-majors.

5. DISCUSSION

Computer programming is offered as a course in many educational departments because of its learning value and for the development of the ability of interactive learning material production. Computer programming is a difficult competence to learn and often presents large failure rates. For the improvement of the situation, several approaches have been proposed including the development of educational programming environments. These languages aim to make computer programming more attractive and accessible to children, novice programmers, and students of non technological disciplines (non-majors). In this direction Scratch system has been selected for use in a course concerning the development of multimedia educational applications offered to students of "preschool education and educational design department" at the University of the Aegean.

Within the framework of this course, a research regarding the investigation of the effects of Scratch familiarization on students' opinions and attitudes towards ICT in education and computer programming has been conducted. Students that participated in the research had basic ICT skills while very few were familiar with computer programming or multimedia processing. Despite this fact, students consider Scratch user friendly and they are satisfied with its features.

As far as the students' attitudes against ICT in education are concerned, familiarization with Scratch seems: to increase the already high percentage of students that declare interest to exploit ICT in education; and to decrease significantly (statistically) the percentage of students with stress and anxiety about their ability to utilize ICT in educational practice. The importance of this result is even more significant if we consider that all of the sample students are females which according to research reports have greater percentage of stress and anxiety about ICT. As far as the internet and application development is concerned there is an increased percentage of students that wish to design internet based learning activities and to program educational applications after the use of Scratch.

Combining the research data, it is possible to claim that Scratch has a rather positive effect on students' opinions and attitudes towards computer programming and ICT educational value increasing the possibilities of successful introduction in computer science and the adoption of effective practices in the educational practice. The research results validate the educational decision of using Scratch in a course of computer programming for future teachers.

In future, this work could be continued: in order to compare Scratch with other similar educational programming environments in terms of influence of students attitudes; to more detailed exploration of the special characteristics of Scratch that make the difference to other environments; to see if the knowledge on programming developed by students can be generalized and transferred to other programming environments; to investigate the effects to other populations such as the in service teachers etc.

6. REFERENCES

[1] Ajzen, I., & Fishbein, M. (1980). "Understanding attitudes and predicting social behavior". Englewood Cliffs, NJ: Prentice-Hall

[2] Fesakis G., & Dimitrakopoulou A., (2005), Cognitive difficulties of secondary education students with programming variable concept and possible interventions, In proceeding of the 3rd Pan-Hellenic Conference on "Informatics Didactics " (Corinth, Greece, Oct, 7-9, 2005), Available online in Greek at: http://www.etpe.gr

[3] Fesakis G., & Dimitrakopoulou A., (2006), Review of educational environments for programming: Technological and Pedagogical Dimensions, in journal THEMES in education , 7(3), pp. 279-304 in Greek

[4] Fesakis G., Dimitrakopoulou A., Serafeim, K., Zafeiropoulou, A., Ntouni, M. & Touka, V. (2008). Introduction the Scratch educational environment. In proceeding of the 3rd Pan-Hellenic Conference on "Informatics Didactics " (Patras, Greece, March,26-28, 2008), Available online in Greek at: http://www.etpe.gr

[5] Guzdial, M. (2004). Programming environments for novices. In S. Fincher, & M. Petre, Computer science education research (pp. 127-154). Lisse, The Netherlands: Taylor & Francis.

[6] Guzdial, M., & Soloway, E. (2002). Log on education: teaching the Nintendo generation to program. Communications of the ACM , 45 (4), pp. 17-21.

[7] Jimogiannis A., & Komis V. (2004), Attitudes and opinions of secondary education teachers against the application of ICT in instruction, In proceedings of the 4th Pan-Hellenic Conference of HICTE on "ICT in Education" (Athens, Greece, Sep 29- Oct 3, 2004), Available online in Greek at: http://www.etpe.gr

[8] Jimoyiannis A., Politis P. & Komis V. (2005), Study of the senior lyceum students perceptions of programming variable concept, In proceeding of the 3rd Pan-Hellenic Conference on "Informatics Didactics " (Corinth, Greece, Oct, 7-9, 2005), Available online in Greek at: http://www.etpe.gr

[9] Maloney, J. H., Peppler, K., Kafai, Y. B., Resnick, M., & Rusk, N. (2008). Programming by choice: urban youth learning programming with scratch. ACM SIGCSE Bulletin, 40 (1), pp. 367-371.

[10] Maloney, J., Burd, L., Kafai, Y., Rusk, N., Silverman, B., & Resnick, M. (2004). Scratch: A Sneak Preview. Proceedings of the Second International Conference on Creating, Connecting, and Collaborating through Computing, January 29 - 30, 2004, Kyoto, Japan (pp. 104-109)

[11] MIT Media Lab. (2008). Scratch. Retrieved OCT 27, 2008, from http://scratch.mit.edu

[12] Monroy-Hernandez, A. (2007). ScratchR: a platform for sharing user-generated programmable media. In M. B. Skov (Ed.), 6th International Conference on Interaction Design and Children. Aalborg, Denmark.

[13] Monroy-Hernández, A., & Resnick, M. (2008, March-April). Empowering kids to create and share programmable media. Interactions , pp. 50-53.

[14] Okamp, S. & Schultz, W.(2005). Attitudes and opinions. Third Edition, Routlenge

[15] Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. New York: Basic Books.

[16] Pea R. (1986), Language-independent conceptual 'bugs' in novice programming, Journal of Educational Computing Research, 2(1), 25-36.

[17] Peppler, K. A., & Kafai, Y. B. (2007). Collaboration, Computation, and Creativity: Media Arts Practices in Urban Youth Cultures. In the proceeding of the Computer Supported Collaborative Learning conference (CSCL2007), July 16 - 21, Rutgers, The State University of New Jersey, USA (pp. 586-588).

[18] Sivilotti, P. A., & Laugel, S. A. (2008). Scratching the surface of advanced topics in software engineering: a workshop module for middle school students. In the proceedings of the 39th SIGCSE technical symposium on Computer science education (SIGCSE '08), March 12 - 15, 2008, Portland, OR, USA (pp. 291-295).

[19] Tzavara A., & Komis V. (2003), ICT in the education of preschool future teachers: Examples of multidisciplinary units, In proceedings of the 2nd Pan-Hellenic Conference on "ICT in Education" (Syros, Greece, May, 9-11, 2003), Available online in Greek at: http://www.etpe.gr

[20] Wiedenbeck, S. (2005). Factors affecting the success of non-majors in learning to program. In the proceedings of the first international workshop on Computing education research, Seattle, WA, USA October 01 - 02, 2005 (pp. 13 - 24).

[21] Wolz, U., Maloney, J., & Pulimood, S. M. (2008). 'Scratch' your way to introductory CS. ACM SIGCSE Bulletin , 40 (1), pp. 298-299.

[22] Yildirim, S. (2000), Effects of an educational computing course on preservice and inservice teacher: a discussion and analysis of attitudes and use, Journal of Research on Computing in Education, 32(4), 479-496