Pre-service kindergarten teachers' acceptance of *'ScratchJr'* as a tool for learning and teaching Computational Thinking and science education.

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Abstract

The innovative educational programming environment called ScratchJr offers young children the possibility to programme their own interactive stories and games. This study aims to investigate the acceptance of ScratchJr by pre-service kindergarten teachers as a tool with which to produce interactive, multimedia learning content for science teaching, as well as a tool for learning and teaching Computational Thinking. Also, the effects of using ScratchJr for future teachers' attitudes in terms of perceived ease of use and usefulness are explored. The study was conducted during the winter term of the academic year 2016–2017 at a university department of early childhood education in Greece. The results show not only that the use of ScratchJr has a statistically significant increase in pre-service kindergarten teachers' self-efficacy in Computational Thinking, but also that they are willing to use it in their future daily practice for science education. Also, the study reveals that pre-service teachers have positive acceptance scores in terms of usefulness and ease of use of ScratchJr. Additionally, no significant difference between the acceptance scores of the participants in terms of programming background, and their studies in the high school from which they graduated, as indicators of programming experience was found. Preliminary analysis of the data shows that ScratchJr is an appropriate educational environment for pre-service kindergarten teachers to learn programming basics as well as a platform for the development of educational resources to support the learning of science teaching.

Keywords: ScratchJr, pre-service kindergarten teachers, Computational Thinking

Intruduction

Several western countries are in the middle of changes regarding school curricula as they see the value of introducing topics such as programming and Computational Thinking (CT) (Bean *et al,* 2015; Duncan, Bell & Tanimoto, 2014). Especially, CT has clearly become an interdisciplinary concept based on, but not limited to, Computer Science (CS) (Saltan & Kara, 2016). As a result, learning programming as well as the development of CT is a teaching subject in many departments of tertiary education that are not necessarily related to CS or technology directly (Fesakis & Serafeim, 2009). Among these, the departments of education, in which pre-service teachers get acquainted with programming and CT, are included. The goal for pre-service teachers is either to teach children the basics of programming or to utilise the knowledge gained for the creation of interactive and multimedia-enhanced learning material, or to teach other subjects such as science education. However, there are risks for teaching programming: if a student is taught programming by a teacher who lacks confidence, there is a possibility that the student will create a negative impression of the subject (Duncan *et al,* 2014; Bean *et al,* 2015). For that, it is necessary for pre-service teachers not only to develop CT, but also a positive attitude and a strong degree of interest and confidence in using programming in their teaching. The present study investigates the effect of familiarity with *ScratchJr (Scratch Junior)* on pre-service kindergarten teachers' opinions and attitudes regarding the usefulness and ease of use

of *ScratchJr.* Additionally, it investigates the contribution of *ScratchJr* to pre-service teachers' self-efficacy in CT, as well as the acceptance by pre-service teachers of the use of *ScratchJr* as a tool for learning and teaching CT and science education.

Method

Study purpose

The purpose of this study was to investigate pre-service kindergarten teachers' acceptance of *ScratchJr* as a tool for learning and teaching CT. The research questions for this study were as follows:

1 To what extent has *ScratchJr* contributed to pre-service teachers' self-efficacy in utilising CT within their future teaching endeavours in programming and science education?
2. To what extent do pre-service teachers accept the usage of *ScratchJr* for learning and teaching CT and science education, in terms of perceived ease of use and perceived usefulness?
3. Is there a difference in acceptance of *ScratchJr* related to programming experience, and the secondary school direction (humanities, science and technology) from which the pre-service teachers graduated?

The sample

The study was conducted during the winter term of 2016-17, at the Department of Pre-School Education of the University of Crete, Greece. The sample comprised 122 female pre-service kindergarten teachers. The students had registered for an optional IT course and voluntarily participated in the study. The *ScratchJr* was chosen as the programming environment. The intervention was carried out in an amphitheatre, where students sat together in small groups (of 2-4) using tablets, and could observe one another succeeding in the task. The first 10 lessons were divided into two parts. In the first part, the students were engaged in an open activity with *ScratchJr,* which introduced a new programming concept or a new *ScratchJr* characteristic. In the second, the students were engaged in group work and were supervised by the teacher.

We carefully selected experiences from the science field that would be both attainable and challenging, and arranged them in increasing complexity. The students were informed that the last three courses would be dedicated to the development of three open-ended design-thinking projects from the fields of science and mathematics.

The ScratchJr programming environment

Several graphical programming interfaces have been developed that allow novices to more easily engage in authentic programming and Computational Thinking activities (Dwyer *et al,* 2013). Drag-and-drop environments have become very popular for teaching programming to young children and novice programmers, as they do not require knowledge of programming syntax but provide an environment where compile-time errors are non-existent (Duncan *et al,* 2014). *ScratchJr* is an introductory programming environment that allows young children (5–7 years) to 'discover' the basic programming concepts by creating projects in the form of interactive stories and games. *ScratchJr* takes advantage of the popularity of mobile devices, since it is available both for smart phone devices with iOS or Android operating systems and screen sizes up to 7 inches (Papadakis, Kalogiannakis & Zaranis, 2016).

Instruments

For data collection, participants were asked demographic questions, open-ended questions, and Likert-type questions, on a 5-point Likert scale, which ranged from 'strongly disagree' to 'strongly agree'. To evaluate the first research question, we adapted a simple survey instrument – Teachers' Self-Efficacy in Computational Thinking (TSECT) from Bean *et al* (2015).

This instrument is intended to capture a sense of the student's self-efficacy in utilising programming and CT within their future endeavours in teaching science education. The scale had good reliability, as the Chronbach's Alpha was 0.95. This survey was given as a pre- and post-test before and after the intervention. Also, to investigate to what extent pre-service teachers accept the usage of *ScratchJr* for learning and teaching CT and science education, in terms of perceived ease of use and perceived usefulness, we followed the research approach of Saltan and Kara (2016). We used a questionnaire adapted from Davis' Technology Acceptance Model (TAM) (1989) (perceived usefulness and perceived ease of use). The second instrument was given after the end of the intervention.

Results

For the first research question, a t-test of the pre- and post-survey scale revealed a statistically significant increase in pre-service teachers' self-efficacy in CT from pre- (M =12.80, SD = 9.22) to post- (M = 30.59, SD = 4.77), $t(121)$ =11.48, p < .0001. Cohen's effect size (d = 1.42) indicated a large positive effect. For the second research question, the participants were asked to respond to 14 items, with answers ranging from 1 to 5 on a Likert-type scale, which evaluated two factors of the TAM model: namely 'Perceived usefulness' and 'Perceived ease of use'. Overall, the 'Perceived usefulness' factor had a mean score of 4.12 (SD=.87), and the 'Perceived ease of use' had a mean score of 3.99 (SD=.51). The mean scores of the items show that participants mainly have positive and similar acceptance ratings for the items and the factors in the scale. For the third research question, the results from independent samples' t-tests showed that there was no significant difference between the 'perceived ease of use' and the 'perceived usefulness' mean scores of the participants regarding their direction at school, as well as their experience from IT-based university courses (Table 1).

Discussion and conclusions

ScratchJr seems to positively contribute to the development of pre-service kindergarten teachers' self-efficacy in utilising programming and CT within their future endeavours in teaching science. From the consideration of research data, it also seems that *ScratchJr* is useful for helping pre-service teachers to use computational constructs, engage in programming processes, acquire programming skills and motivation, and develop positive attitudes toward programming and usage in teaching science education. Also, the study's results revealed that pre-service teachers mainly have positive and similar acceptance of *ScratchJr* in terms of usefulness and ease of use, regardless of the school direction or their experience in IT university courses. Based on these findings, we believe that *ScratchJr* is appropriate to function as an introduction to basic programming concepts and CT, as well as the development of educational applications from kindergarten teachers.

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	Humanities direction	Science–Technology direction	Independent samples t-test	Experience in IT university courses	Non-experience in IT university courses	Independent samples t-test
Perceived usefulness	(M=4.01, SD=.91)	(M=4.31, SD=.82)	$t(120)$=.95, p>.05	(M=4.12, SD=.53)	(M=3.98, SD=.55)	$t(120)$=.83, p>.05
Perceived ease of use	(M=3.74, SD=.54)	(M=4.20, SD=.39)	$t(120)$=.98, p>.05	(M=4.0, SD=.39)	(M=3.90, SD=.44)	$t(120)$=.89, p>.05

Table 1: Mean, standard deviation and independent samples t-test.

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Appendix
Instruments

❒ *Take-home written task*

Which factors do you believe influence the quality and effectiveness of your teaching in science?
As these factors are formed by your personal views and ideas as well as by your classroom experiences, please provide a description and elaborate briefly on them where possible to make them clearer.

❒ *Teacher-constructed questionnaire*

Please construct a questionnaire that you would use to investigate the factors that early childhood teachers of science believe may influence the quality of their teaching of science.

❒ *Individual questionnaire*

1. Do you think that the factors that you reported in your written task are related to each other? More specifically, which of these factors do you believe influence other factors and in what way?
2. Do you believe that these factors have been affected by your own education? How so?
3. Are there any affective factors mentioned in your written task? What are these affective factors and how would you describe them?
4. Do you think that a teacher's creativity is a factor that can contribute to the quality of his/her teaching in science? If so, how do you think it contributes?
5. In the case of implementing pre-designed science activities in the classroom, how do you think that a teacher's creativity can contribute?
6. Do you think that some of the factors you reported in the written task depend on the teacher's knowledge? If so, which types of teachers' knowledge?
7. Do you think that some of the factors you mentioned in the written task are topic-dependent, i.e. are related to the science topic you are teaching?
8. Do you think that teachers' knowledge of how to praise children is a factor that could influence the quality of your teaching in science? Was this mentioned in your written task?
9. Are there factors that are outside your control that can influence the quality of your teaching of science? If so, what are these factors?
10. Has the development of any instructional materials, or your participation in any research activities related to your work, influenced the quality of your teaching of science? If so, what were these activities and how did they influence your teaching?
11. Do you have any other comments on what factors may influence the quality of your teaching of science?

❒ *Focus group interview*

Questions will be formed by the interviewer on the basis of results coming from the preliminary analysis of the written task. Are similar to the individual questionnaire and will generate discussion from the participants.

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