Assessing algorithmic thinking skills in early primary school amid environmental studies

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Abstract

The presented work introduces part of a wider project aiming for the development and the assessment of fundamental computational thinking skills in early childhood education. More precisely, the part of the project that is presented refers to an assessment tool constructed by the authors, which focuses on evaluating algorithmic thinking skills of first and second grade primary school students. It employs data collection instruments and analysis techniques of mixed method research methodology and it is proposed to be applied in the classroom amid environmental studies. A relevant research conducted is also discussed, which focused on establishing validity and reliability of the results provided by the assessment tool, evaluating students' algorithmic thinking skills and testing the relationship between algorithmic thinking skills and the levels of the content understanding of the course.

Introduction, Objectives, or Research Questions

Nowadays, the cultivation of computational thinking is considered an essential objective at all educational stages worldwide (Barr et al., 2011; Barr & Stephenson, 2011; Grover, 2015), since it is expected that, by the second half of the 21st century, it will be recognized as a basic skill, just like reading, writing and arithmetic are at present (Wing, 2006). An issue that arises is the variety of opinions about what the basic aspects of computational thinking are. Nonetheless, convergence of opinion occurs about the fact that algorithmic thinking is a basic pillar of computational thinking (Wing, 2006).

The research questions of the presented investigation focus on: (a) the examination of the validity and the reliability of the results provided by the proposed assessment tool, (b) the evaluation of students' algorithmic thinking skills and (c) the exploration of the correlation between students' algorithmic thinking skills and the levels of the content understanding of the environmental studies course. The last two issues are also examined in relation to the gender and the class of the students.

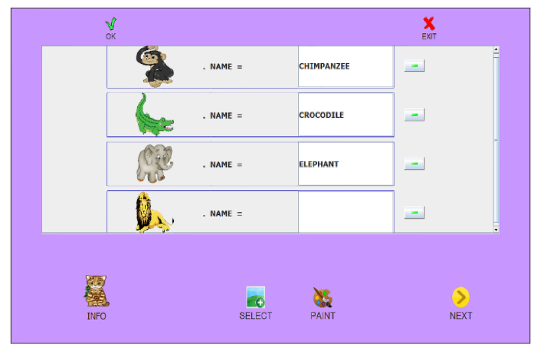


Figure 1. Assigning values to the attribute "NAME".

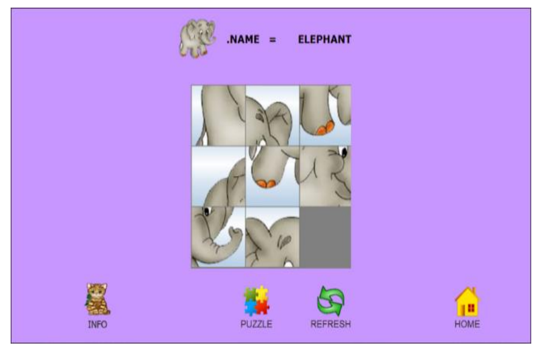


Figure 2. A 9-piece elephant puzzle.

Methods and Materials and/or Conceptual Framework

The backbone of the assessment tool is the digital platform PhysGramming (Kanaki & Kalogiannakis, 2018). The thematic unit employed for the presented research was animals' eating habits. The student chooses and/or paints the pictures of the animals and specify their names by assigning them to the relevant attribute (Figure 1). PhysGramming provides an equal number of puzzles (Figure 2). At a quantitative level, the researchers test the children's ability to solve puzzles in relation to the kind of puzzles they solve (4, 6, 9, 12-piece puzzles), by examining PhysGramming's log files. At a qualitative level, personal interviews were conducted, recording the students' work plan.

As far as content understanding is concerned, students had to declare the nutrition habits of 12 animals found in Greece in a relevant worksheet.

Results or Findings

The research was conducted by the authors in 2019, in the city of Heraklion, Crete, Greece. The participants (N = 435, 48.5% female) were primary school students in first grade (50.1%) and second grade (49.9%).

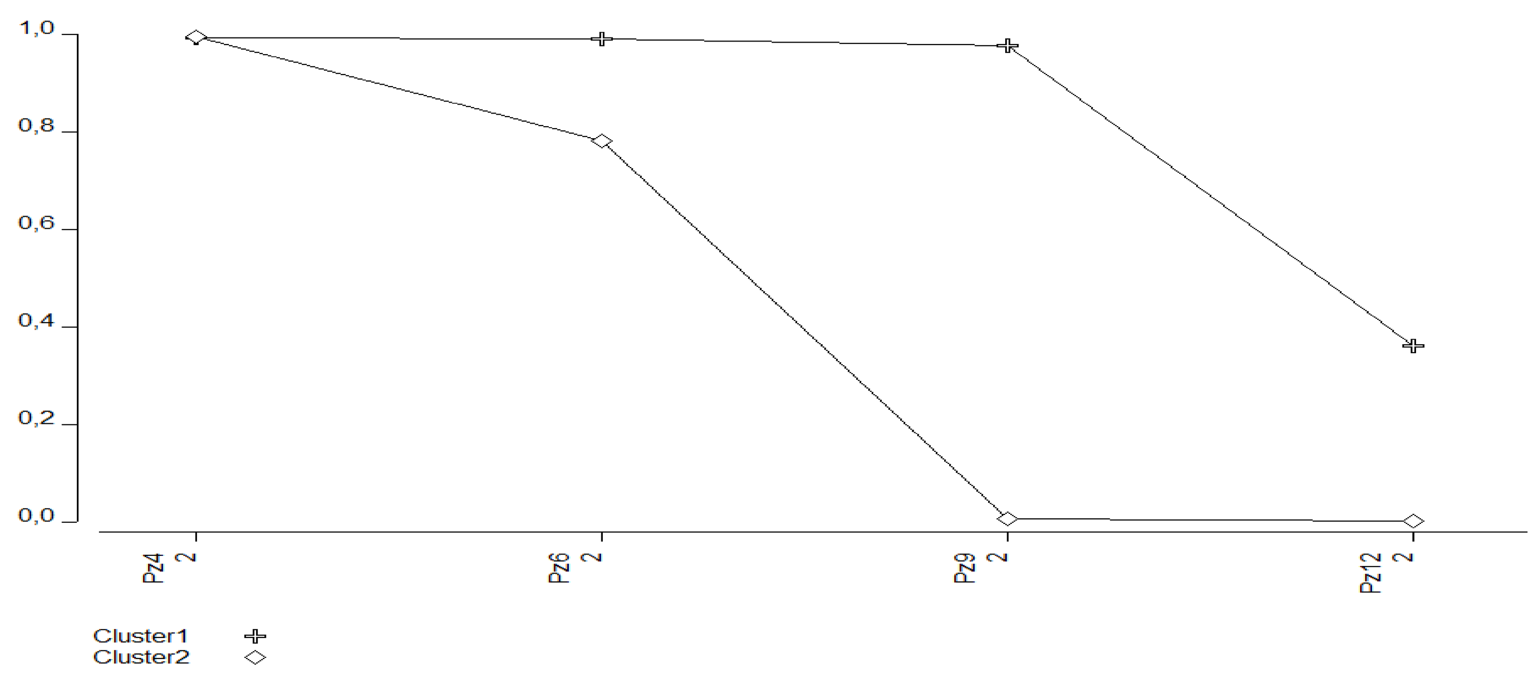
Latent Class Analysis (Stamovlasis et al., 2018) leads to a two-cluster solution as the best parsimonious model with the lowest BIC values. Cluster 1 (51.49%) includes students having high probability of success in solving 4, 6 and 9-piece puzzles, and with a low probability of success in solving 12-piece puzzles. Cluster 2 (48.51%) includes students having high probability of success in solving 4 and 6-piece puzzles, which however fail in solving 9 and 12-piece puzzles. Cluster 1 is positively associated with the second group ($b = 0.627$, $p < 0.01$) and negatively associated with the first group ($b = -0.627$, $p < 0.01$). That is, students with the highest algorithmic thinking skills most probably followed some kind of plan. Cluster 1 is positively associated with the excellent level of content understanding ($b = 0.227$, $p < 0.01$). The opposite holds for Cluster 2.

Table 1. The association of cluster membership with the covariates. Coefficients, standard deviation, z-values, Wald and p-values..

	Cluster1	SD	z-value	Cluster2	SD	z-value	Wald
Gender							
Boy	0.094	0.052	1.79	-0.094	0.052	-1.79	3.20*
Girl	-0.094	0.052	-1.79	0.094	0.052	1.79	
Grade							
First	-0.118	0.053	-22.15	0.118	0.053	22.15	4.91**
Second	0.118	0.053	22.15	-0.118	0.053	-22.15	
Content understanding							
Aprox. Good	-0.248	0.095	-26.07	0.248	0.095	26.07	13.69***
Good	-0.139	0.093	-14.93	0.139	0.093	14.93	
Very Good	0.160	0.086	1.87	-0.160	0.086	-1.87	
Excellent	0.227	0.093	24.48	-0.227	0.093	-24.45	
Plan							
without plan	-0.627	0.199	-31.53	0.627	0.199	31.53	9.94***
with plan	0.627	0.199	31.53	-0.627	0.199	-31.53	

* p < 0.05 (one tail), ** p < 0.05, *** p < 0.01

Conditional probabilities of the two clusters/latent classes representing the levels of algorithmic thinking skills



Discussion

In an attempt to globally evaluate our research approach, in terms of the impact it had on the members of the educational community who participated in the research, we would say that the proposed assessment tool was very easily accepted by students and teachers. Especially the piece that had to do with solving puzzles immediately became beloved by the students. The fireworks that are presented after solving each puzzle were especially joyful for the young users.

The proposed assessment tool could be used amid other courses, such as Mathematics, in order to meet the same goal i.e., the evaluation of structural elements of students' computational thinking. In fact, conducting relevant research is one of our future research projects.

Conclusions or Implications

In the modern digital era, the demand of societies to develop students' computational thinking skills at all stages of compulsory education has attracted the attention of researchers, educators and policy makers all over the world and provoked relevant inquiries. Responding to this request, the authors attempt a novel contribution to the relevant research area, reemphasizing that an essential requirement for the effective development of computational thinking skills is the construction of assessment tools developmentally appropriate for the target groups.

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