ABOUT THE CONCEPT OF COMPUTATIONAL THINKING AND ITS EDUCATIONAL POTENTIALITIES BY PRE-SERVICE TEACHERS

Merixtell Estebanell Minguell¹, Juan González Martínez², Marta Peracaula Bosch¹, Víctor López Simó³

¹ UdGitalEdu, Universitat de Girona (SPAIN)
² Universitat de Girona. Serra Húnter Fellow (SPAIN)
³ CRECIM. Universitat Autònoma de Barcelona (SPAIN)

Abstract

Since its introduction by Papert [1] and its application to the educational field by Wing [2], computational thinking has been experiencing a growing development in recent years in all levels of compulsory education and also in the informal field. Undoubtedly, computational thinking helps individuals to better cope with learning challenges and even with everyday life challenges themselves; in addition, it is motivating for young people, and because of that, it is frequently offered as a common activity outside school or inside the curriculum. In Catalonia, different governmental initiatives consider the inclusion of programming and robotics in the ordinary classroom as a result of that; in fact, it is considered positive to generalize the computational thinking in the compulsory education system, because of its many possibilities and its many potentialities.

However, nowadays the Faculties of Education do not form teachers prepared to teach computational thinking to their future students, which may run the risk of not having professionals prepared enough in this regard. Because of this, the PECOFIM project is investigating the most effective ways to train future teachers in computational thinking. As a first part of this project, a descriptive analysis of the initial level of knowledge and expectations on computational thinking as a training strategy for the pre-service teachers of the two participating universities has been carried out, and preliminary data offer us an interesting view on the status quo in this regard.

Although the informants generally offer a precise definition of computational thinking, the preconception we detect in them is always closely linked to the experiences they have had in this respect and, therefore, it is related to robotics or programming, in an often quite restrictive vision.

Students show a high level of expectations about the educational possibilities of computational thinking in Primary Education, although their expectations are excessively linked to the instrumental domains related to programming itself and not to its incidence in the development of the other literacies and abilities. In addition, they are able to recognize in general terms which are the most relevant elements of the didactic strategies that allow students to develop it. However, even those who have been trained in robotics feel unprepared to act as teachers in computational thinking. As a last positive, it is important to emphasize that in any case the interest of the pre-service teachers to train in computational thinking is high.

Keywords: computational thinking, pre-service teachers.

1 THE COMPUTATIONAL THINKING IN EDUCATION

Several studies and reports have pointed out that Computational Thinking improves some very specific problem solving skills, such as the ability to think logically. On their own, Brennan and Resnick [3] point out three dimensions of Computational Thinking, which are computational concepts (concepts that designers use when programming, such as sequences, events, loops, parallelism, etc.), computational practices (that designers develop when they program, such as incremental and iterative development, trial and error, abstraction, modularization, etc.) and finally computational perspectives (that is, perspectives that designers form about their surroundings and about themselves, such as learning to express, connecting, questioning, etc.).

As a natural consequence of this, there are many initiatives that attempt to exploit all these potentialities within the educational field. In fact, Computational Thinking allows to improve the fun and the motivation when exploring the learning of very diverse concepts, not only mathematical [4]. Hence it is useful for the general population, not only for computer scientists [2] and so it is considered a basic and transversal literacy for citizenship [5].
It is no coincidence, therefore, that in our environment there are more and more schools and educational initiatives related to educational robotics and computer programming that can be found, for example, in the LEGO-Mindstorms or We-DO educational kits, in The Bee-Bot children's robots, the Scratch and ScratchJr programming platform or the Arduino microcontroller boards, among others. In recent years, several initiatives have been launched to encourage computational thinking at local and national level: campus, code clubs, museums, European projects and networks, etc.

We understand Computational Thinking as a way of orienting the analysis and resolution of problems, which involves decision making, autonomy and teamwork abilities, being able to seek new and imaginative solutions. And this go over what is directly a subject to become a way of facing life, with a creative and enterprising attitude. And that is why we must act in all stages of education, beginning with the stages of Early Childhood and Primary Education.

However, to achieve this, the first step that needs to be done is to get teachers to assimilate this change of mentality and incorporate it into their educational practice (in their classroom work), and that future teachers explore it during their formation (in order to apply it in their future professional).

Therefore, as the first phase of the PECOFIM research project (The Computational Thinking in the initial teacher training process), we offer an analysis of the initial concept and attitudes about the TC of the pre-services teachers from a survey

2 METHODOLOGY

The present research is a descriptive analysis with qualitative and quantitative data carried out during the beginning of the year 2017 through a specific created questionnaire. This survey sought to explore the following questions:

- What do pre-service teachers know about Computational Thinking before being trained in it?
- What importance do they assign to different elements of Computational Thinking?
- What elements of Computational Thinking do they recognize as such?
- Which are their attitudes and expectations about Computational Thinking?

116 students in the Primary and Early Childhood Education Degrees at the Universitat de Girona and the Universitat Autònoma de Barcelona answered the survey, with the following summary profile: 14% were men, 86% were women; 30% said they had participated in previous experiences related to robotics and programming, and 70% said they had no previous experience.

Qualitative data were coded from an ad hoc category codebook created after the exploratory analysis; quantitative data were debugged, tabulated and analyzed with basic descriptive statistics

3 RESULTS

The text included in the sections or subsections must begin one line after the section or subsection title. Do not use hard tabs and limit the use of hard returns to one return at the end of a paragraph.

3.1 What do pre-service teachers know about Computational Thinking before being trained in it?

As we can see in Table 1, the pre-service teachers know only partially the concept of Computational Thinking. Few of them (3.4%) are able to define it properly when we ask for it. Most (69%) produce definitions more or less close to what we mean by CT. And almost a third of the informants do not know what Computational Thinking is, they recognize it explicitly or not (when they produce answers that have nothing to do with the concept).

<table>
<thead>
<tr>
<th>Do they know what CT is?</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>They know it</td>
<td>3.4</td>
</tr>
<tr>
<td>They know it partially</td>
<td>69</td>
</tr>
<tr>
<td>They don’t know it</td>
<td>16.4</td>
</tr>
<tr>
<td>They say they don’t know it</td>
<td>11.2</td>
</tr>
</tbody>
</table>

6625
In Table 2, we can see how we can organize the different kind of answers offered by the students when asked to produce their definitions of Computational Thinking. Many of them relate it to the ability to solve problems in general (21.4%) or with the use of technology (17.3%). And another important group of informants associates it with programming processes of computer devices (22.4%). The rest of the informants offers definitions related to educational topics in general (1%), information management (2.6%), or other more general approaches (4.1%). As we can see, few are really close to the concept of real CT (4.1%).

Table 2. What do they think CT is? They say CT is something related to…

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming</td>
<td>22.4</td>
</tr>
<tr>
<td>Some educational issues</td>
<td>1</td>
</tr>
<tr>
<td>Task solving</td>
<td>21.4</td>
</tr>
<tr>
<td>Task solving with technology</td>
<td>17.3</td>
</tr>
<tr>
<td>Computational thinking</td>
<td>4.1</td>
</tr>
<tr>
<td>Imprecise definitions</td>
<td>6.1</td>
</tr>
<tr>
<td>Information managing</td>
<td>2.6</td>
</tr>
</tbody>
</table>

3.2 What importance do they assign to different elements of Computational Thinking?

In this second section, we asked our pre-service teachers what elements they considered to be essential, useful or irrelevant from an educational point of view. We offered a list of 9 elements, including three elements related to Computational Thinking (task segmentation, decision making and testing), three more related to digital competence (information management, communication and management of risks) and the last three of them related to other transversal competences (rules, autonomy and coordination). As we see in Figure 1, in general, the elements related to TC are those that are less perceived as essential in the educational field, as opposed to elements related to transversal competences and to digital competence.

Figure 1. How do pre-service teachers perceive the importance of some educational issues?
3.3 What elements of Computational Thinking do they recognize as such?

Following with the same elements of the previous section, then we asked the participants to indicate if they considered that these elements belonged to the CT concept or not. Although the element they most generally considered part of Computational Thinking, decision making, indeed is one of them, in general it seems that it is not clear to our pre-service teachers what elements are specific to the CT and which are not. In fact, it can be seen that information management and the risks associated with the network are elements that they do consider part of the CT concept, while they are preferably associated with digital competence. And, on the other hand, testing, one of the traits associated to our concept, is hardly identified in that way by the half of the sample. All these questions can be seen in Figure 2.

![Graph showing perceptions of educational issues related to Computational Thinking](image)

**Figure 2. How do pre-service teachers perceive the link between some educational issues and CT?**

3.4 Which are their attitudes and expectations about Computational Thinking?

Finally, as we can see in Figure 3, we were interested in the attitudes and expectations of the pre-service teachers in relation to Computational Thinking, and for that reason we asked them if they felt well trained in this regard, if CT seemed interesting to them, which was their own ability as teachers to include TC in their educational practice, if they felt safe for designing TC activities and if TC itself seemed relevant from an educational point of view. In general, the attitudes and expectations of our sample are positive, considering that they say that TC is relevant and interesting. However, as expected, they do not feel very enthusiastic about their own ability as future teachers to design and implement learning experiences linked to Computational Thinking. And, as we can see as well, this has much to do with the idea that, in general, they feel little formed about it.
4 CONCLUSIONS

As we said at the beginning, Computational Thinking is an increasingly frequent strategy in many schools. And this, because it can allow us to improve the ability of students to solve complex tasks of their daily and academic lives, not only in subjects related to computing [3], [4]. However, pre-service teachers are not trained in Computational Thinking and therefore we wondered if in these training plans at Educational Faculties we should start with the CT concept itself in order to get future teachers aware of its interesting and numerous potentialities.

As we can see, the knowledge of pre-service teachers on Computational Thinking is partial and linked more to stereotypes than certainties. They are able to place CT in spheres close to problem solving or computing, but we hardly find a deep understanding of this concept. In addition, they have problems to identify properly the CT-inherent elements and consider, perhaps because of their lack of specific knowledge, that other educational topics are more important than the CT elements that we have showed to them.

However, and this is the positive part of all, their expectations are quite positive. They consider that CT is interesting and relevant for education. And they think they're not very well trained for using it as teachers. That is where we must situate ourselves if we want to offer to our pre-service teachers quality training on CT, in relation to what the European agenda demands [5].

ACKNOWLEDGEMENTS

The PECOFIM project, with the identifier 2015 ARMIF 00031, is funded by the ARMIF 2015 Call for Research Grants for the Initial Training of Teachers of the Agència de Gestió d'Ajuts Universitaris (AGAUR) of the Generalitat de Catalunya.

REFERENCES