

# Approaches of Learning and Computational Thinking in Students that get into the Computer Sciences Career

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## ABSTRACT

The way in which the student processes the information, codifies it and recovers it, constitutes its learning approach. The learning process differentiates two qualitative ways of dealing with this process: the deep approach and the superficial approach. The use of each approach depends on the context. However, the adoption of a deep learning approach is positively related to the academic performance. Computational Thinking is defined as a competence of the XXI century, which allows solving problems from a computational point of view, and there is a variety of instruments that allow to measure it, and to know the state in which the evaluated student is. In this paper, we verified the existence of the positive significant relationship between the learning approach and computational thinking in students entering the career of Computer Sciences. By applying Pearson correlation test to verify the relationship between Learning Approaches and Computational Thinking, we found that both variables have homogeneous behaviors and that students show similar conditions. Men are in better conditions than women on the evaluated aspects of the Computational Thinking. Also, we found a significantly positive relationship between Computational Thinking and the Learning Approach ( $r = 0,882$ ). This result shows that the learning approaches that students practice are linked to the computational thinking they demonstrate.

According to the results, the teachers of this career must develop active and deep methodological strategies due to the predisposition in these students.

## CCS CONCEPTS

**Applied computing** → Education

## KEYWORDS

Learning Approach, Computational Thinking, Career of Computer Sciences

## 1 INTRODUCTION

The way in which the student processes the information, codifies it and recovers it, constitutes its learning approach [1]. The learning approach is the student's intention to learn and the way in which he/she learns, so that in the teaching-learning process the most important thing is not what the teacher does, but what the student does [2, 3, 4, 5].

The Learning Approaches and their relationship with Computational Thinking have been little studied in the university environment. Its study has been extended in public schools in Latin America due to the bi-directional nature of the learning approaches where the influence of the academic context and the nature of the contents to be learned are considered to improve the quality of the educational process [4]. The learning process differentiates two qualitative ways of dealing with this process: the deep approach and the superficial approach. The use of each approach depends on the context. The approaches can be manipulated by the student's intention, which is motivated by their intrinsic motivation or extrinsic motivation, which has led to a conversion process in the student, in order to improve learning. However, the adoption of a deep learning approach is positively related to the Academic Performance [6, 7]. In other studies in which a significant correlation between learning approaches has been demonstrated, it is recommended to enhance the students' deep learning because they will learn more and better, and thus it is much more likely that they will do better. For this, it is proposed that teachers promote high-level goals with methodologies, other than merely expository teaching. Thus, it is suggested that teachers work on solving problems, encourage critical thinking, and arbitrate the most demanding evaluation procedures [8]. It was also found that there is a relationship between learning approaches and other factors, such as the personality of the student, that influence the learning process. Therefore, it is proposed that the teacher facilitate tasks and school activities that require a deep focus [2, 9]. Soler and Romero [9] carried out a research in which they demonstrated that

students with a deep learning approach possess an intrinsic motivation that gives them the ability to lead and achieve the integration of their classmates in a ludic activity; which demonstrates that there is a dependence between the context and the nature of the task proposed to the students.

In the research on learning strategies according to the learning approaches presented in [10], the learning of the theory of constructivist psychology was proposed for fifth-year medical students, where 76% of these students apply the strategic approach in the "search for achievements" of the questionnaire on learning strategies. The researchers considered that it could be attributed to three contextual factors: first, the students approved the subjects in the first instance, constituting themselves in a group with Academic Performance in search of success; the second could be the course, since the students of the last year of their undergraduate training respond better to the demands of the context and, finally, the third was the grade, since it was the evaluation system on 100 points and the minimum approval of 51. The subjects studied are graded with the grading system B (which means a score of 35% on average of two theoretical partial tests, 25% on practice and 40% on a final exam), which shows that the system assigns a higher score to the theoretical and final component of the process [10].

Computational Thinking is defined as a competence of the XXI century, which allows solving problems from a computational point of view. Computational Thinking (CT) was made popular by J. Wing, who remarks that some of its characteristics are: thinking like a computer scientist requires thinking at multiple levels of abstraction; CT is a way humans solve problems; computer science inherently draws on mathematical and engineering thinking, and its formal foundations rest on mathematics, and we can build systems that interact with the real world; and we use computational concepts to approach and solve problems, manage our daily lives, and communicate and interact with other people [11]. According to [12], it is important to introduce coding, code literacy or CT in pre-university studies, and to emphasize that CT is the application of a high level of abstraction and an algorithmic approach to solve any type of problem. Although it does not yet have defined levels of development, there is a variety of instruments that allow to measure Computational Thinking, and to know the state in which the evaluated student is.

In this paper, we propose to evaluate if there is a significant relationship between learning approaches and computational thinking in students entering the career of Computer Sciences. This paper is organized as follows: next section presents the methodology used; then, some results and its discussion are presented; finally, we present some conclusions and future lines of work.

## 2 METHODOLOGY

The context of the research lies in students entering the career of Computer Sciences in which their approach to learning and the aspects related to Computational Thinking have been measured, as established by the Román González instrument [13]. This

instrument evaluates Directions, Loops, Conditional and Simple Functions. To do this, we propose the need to determine if there is a significant relationship between learning approaches and computational thinking in these students, since there must be some degree of inclination regarding their professional training. And so to guide the teaching role with respect to the type of learning approach that the student has, since the relationship of the influence of the approaches on Computational Thinking has not been taken into account for the management of strategies. While some authors find a positive relationship between performance and deep learning approach and a negative relationship of performance with the superficial learning approach, others only partially support these relationships or find contradictory results [1].

In particular Biggs proposes a pedagogical design focused on the SOLO taxonomy (Structure of Observed Learning Outcome) [14], which distinguishes between superficial learning and deep learning. As students learn, the results of their learning first show quantitative and then qualitative phases of increasing structural complexity. Table 1 shows the levels of the SOLO taxonomy.

**Table 1.** SOLO taxonomy

	Level	Description
DEEP LEARNING	SOLO 5	Extensive summary, the student has the ability to generalize the structure far beyond the information presented, also he/she produces new hypotheses or theories that can then be analyzed.
	SOLO 4	Relational, the student can link and integrate many parts in a coherent whole, the details are linked to the conclusion and its meaning is understood, also he/she has the ability to relate, compare, etc.
SUPERFICIAL LEARNING	SOLO 3	Multistructural, the student can focus on many relevant aspects, but considers them independently.
	SOLO 2	Uniestructural, the student has the ability to identify only one relevant aspect, in following a procedure and repeating it.
	SOLO 1	Pre-structural, the student has no understanding, he/she uses irrelevant information.

This taxonomy can be used to design courses that aim for the student to achieve deep learning.

It is worth mentioning that we have not found this didactic approach to those who are entering this professional career.

To measure learning approaches, the Study Process Questionnaire [3] has become a good instrument to evaluate how the student

learns and to assess the teaching context as suggested by the indicators of the 3P learning model. This model has three phases:

- *Presage* as the learning characteristics existing prior to the learning engagement; considers independent variables that refer to the student (for example, previous knowledge about the subject, interest, ability, etc.) and the teaching-learning context.
- *Process* as the student learning experiences capture tool. In this stage the student's activities related to the learning approach are determined.
- *Product* as the overall student learning outcomes capture toolkit. Here are factors that interact with each other: quantitative factors (data, skills), qualitative factors (structure, transfer) and affective factors (commitment) as well as learning outcomes.

So, the 3P model describes how students differ, within a teaching context, in their approach to learning; describes how the student handles specific tasks and varies their approach according to the demands of those tasks (for example, in what way the teachers evaluate); and it can help to describe how the teaching context can be different, from one educational institution to another, from one course to another, suggesting when a system is working or not, by inducing a superficial approach to a deep approach [5, 15].

To measure Computational Thinking, the Computational Thinking Test was used, which is shown in Table 2.

**Table 2. Computational Thinking test**

CT ASPECT	ÍTEM
Basic Sequences (Directions and Turns)	1 to 4
Loop (Repeat $n$ Times)	5 to 8
Loop "Repeat Until"	9 to 12
Simple Conditional "If"	13 to 16
Composite Condicional "If Else"	17 to 20
Condicional "While Condicional"	21 to 24
Simple Functions	25 to 28

This research was applied, not experimental, and the level of research was relational because it sought to determine dependence between learning approaches and computational thinking. The Study Process Questionnaire [3] was used to evaluate learning approaches. This questionnaire was applied only once, which is why it is a cross-sectional and prospective study. For Computational Thinking (CT) the Román González test [13] was used.

An intentional non-probabilistic sampling was carried out. The participants voluntarily agreed to participate in the study. The sample consisted of 63 incoming students, of which 21% had a preference for the superficial approach and the remaining 79%

said they used the deep approach. The CT test was applied to 37 students who agreed to its application.

### 3 RESULTS AND DISCUSSION

The reliability of the Study Process Questionnaire was evaluated with the Cronbach's Alpha test [16], obtaining the value 0.77. This value is considered acceptable according to George and Mallery; and for Huh, Delorme & Reid, the reliability value in confirmatory studies should be between 0.7 and 0.8 [17].

For data processing, a descriptive analysis was performed to characterize the sample using the Excel and SPSS 23 programs. The normality test of the data was performed in general, and then grouped with respect to the type of approach and intensity. The preliminary normality test suggested performing the Pearson correlation test to verify the relationship between the variables: Learning Approaches and Computational Thinking, assuming the 95% confidence interval. These results are shown in Tables 3 and 4.

**Table 3: Test of normality of Computational Thinking**

	Shapiro-Wilk		
	Statistical	gl	Sigma
Computational Thinking	0.108	37	0.065

**Table 4: Test of normality of the Learning Approach**

	Kolmogorov-Smirnova		
	Statistical	gl	Sigma
Learning Approach	0.069	63	0.200*

It is observed in both cases that the distribution of data is normal ( $\sigma > 0.05$ ). This means that both variables have homogeneous behaviors and that in some way the students show similar conditions for both variables. This is because all have passed the process of admission to the career that consists of passing a multiple-choice test that measures the minimum conditions that demonstrate the terminal competences of regular basic education, that is, academic performance.

When students try to achieve a certain qualification as an objective expression of their performance, they condition their learning approach to achieve it [2, 7, 17, 18]; therefore, it was considered that the performance to be achieved would determine the learning approach to adopt. Table 5 shows the normality tests of the learning approach with performance scale factors.

**Table 5: Tests of Normality of the Learning Approach with performance scale factors**

Performance scale		Shapiro-Wilk		
		Statistical	gl	Sigma
Approach	Start	0.910	4	0.480
	In process	0.953	14	0.600
	Achievement	0.976	37	0.592
	Satisfactory achievement	0.921	8	0.442

All cases show parametric behaviours for academic performance. This analysis was done to identify how students demonstrate their learning approaches with the marks obtained in the first phase of evaluation of the first semester of the career. In Table 6, the results of the analysis made by the students regarding the Computational Thinking test according to sex are observed.

**Table 6: Analysis of normality by sex**

	Sexo	Shapiro-Wilk		
		Statistic	df	Sigma
CT	0	0.828	17	0.005
	1	0.943	20	0.272

The results show that male students (1) show homogeneity with respect to the four aspects measured in the test and female students (0) show heterogeneity, that is to say that some female students show conditions for programming and others do not.

Using the Román González scale, we find that the students evaluated show similar results to students who are between 6th grade and 2nd grade ESO (for this the scale of Román González's doctoral thesis was used). This is evident since the origin of the students is varied from the Educational Institutions where they have completed their studies, and it can be inferred that the curriculum of regular basic education has not incorporated abilities related to Computational Thinking. Table 7 shows the descriptive results.

Table 8 shows a significantly positive relationship between Computational Thinking and the Learning Approach ( $r = 0,882$ ). This result shows that the learning approaches that students practice are linked to the computational thinking they demonstrate.

The relationship between the deep learning approach and performance is significantly greater with respect to the relationship between the superficial learning approach and performance; as well as other authors have demonstrated [2, 8, 10, 18].

**Table 7: Descriptive results**

Statistics	Comment	Value
N	Valid	37
	Missing	0
Mean		14.7297
Std. Error of Mean		0.62198
Median		14.0000
Mode		11.00
Std. Deviation		3.78336
Variance		14.314
Skewness		0.609
Std. Error of Skewness		0.388
Kurtosis		-0.794
Std. Error of Kurtosis		0.759
Minimum		9.00
Maximum		22.00
Percentiles	10	11.00
	20	11.00
	25	11.00
	30	12.00
	40	13.00
	50	14.00
	60	15.00
	70	16.00
75	18.00	
80	18.80	
90	21.00	

**Table 8: Correlation between Learning Approaches and CT**

	Approach	
Performance	Pearson correlation	0.882*
	Sigma (bilateral)	0.001
	N	63

Considering that students will be future professionals in the computational context, it is necessary to focus their learning approach towards the deep type so that in addition to obtaining satisfactory grades, they are able to use this intrinsic motivation

and thus be able to deepen and carry out the activities of programming as an abstract form of development in their professional field.

To ensure that the student is motivated and applies study strategies, teachers must use methods, techniques, strategies and procedures to convert extrinsic motivation into intrinsic motivation. It is also necessary that the student knows the use of strategies to make the most of their time and thus the learning of programming is successful and of quality. In order to help both teachers and students to achieve this goal, in [19] a recommender system focused on the pedagogical intention of the learning session that the teacher designs is presented. This recommendation system uses the Biggs SOLO Taxonomy and suggests the most appropriate learning resources according to the educational purpose of the teacher.

## 4 CONCLUSIONS

We verified the existence of the positive significant relationship between the learning approach and computational thinking in students entering the career of Computer Sciences. For Computational Thinking it is evident that men are in better conditions than women on the evaluated aspects of the CT. According to the results, the teachers of the career must develop active and deep methodological strategies due to the predisposition in the students.

According with [20, 21] to develop young students' logical thinking skills and problem-solving skills throughout computational thinking is very important. So, it is necessary to focus the students' learning approach towards the deep approach so that not only do they get satisfactory grades, but they are also able to use this intrinsic motivation to be able to deepen and approach the programming in an abstract form of development in their professional field. To ensure that the student is motivated and applies study strategies, the teachers of the career must use methods, techniques, strategies and procedures to convert extrinsic motivation into intrinsic motivation. It is also necessary that the student knows the use of strategies to make the most of their time and learning programming is successful and quality.

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