# Evolution of Motivational Factors during an Introductory Programming Course

Tania Garbin
Universidade Federal de Ouro Preto
UFOP, Brazil
trossigarbin@gmail.com

Carlos Alberto Dainese
Universidade Federal de Ouro Preto
UFOP, Brazil
cdainese@ufop.edu.br

Calana Chan
Macao Polytechnic University, Macao, China & CISUC, University of Coimbra, Coimbra, Portugal
calanachan@mpu.edu.mo

Philip I.S. Lei
Macao Polytechnic University, Macao, China & CISUC, University of Coimbra, Coimbra, Portugal
philiplei@mpu.edu.mo

Chan Tong Lam
Macao Polytechnic University
Macao, China
ctlam@mpu.edu.mo

Anabela Gomes
Polytechnic University of Coimbra, Coimbra, Portugal & CISUC, University of Coimbra, Portugal
anabela@isec.pt

António José Mendes
Dep. of Informatics Engineering, CISUC, University of Coimbra
Coimbra, Portugal
toze@dei.uc.pt

*Abstract*— **This research-to-practice paper describes a study of motivational factors in introductory programming learning. Learning to program is challenging, as students need to develop multiple skills and competencies. Motivation drives students to confront complex challenges, persevere despite obstacles, and continuously strive for improvement. However, motivation is a complex interplay of internal and external factors. Analyzing the factors that can stimulate student motivation is essential for educators when planning and implementing learning activities and contexts. Therefore, we conducted a study to a) identify factors influencing the motivation of programming students and b) analyze the evolution of students' motivation during the different phases of a programming course. The study involved 137 students enrolled in a Programming I course at a Macao higher education institution. It used the motivation section of the Motivated Strategies for Learning Questionnaire (MSLQ), which comprises 31 statements grouped into six components (Intrinsic Goal Orientation (IGO), Extrinsic Goal Orientation (EGO), Value of Activity (VAT), Control of Learning (COL), Learning Self-Efficacy (LSE), and Test Anxiety (TAX)). These components can be organized into three factors (Value Components, Expectancy Components, and Affective Components). The students were asked to answer the questionnaire in three different moments: the initial phase of the course (3-4 weeks after its start), after knowing the results of the mid-term exam, and at the end of the course. For the analysis, only the answers of the 92 students who completed the questionnaire in the three phases were considered. We applied Principal Component Analysis (PCA) to identify the evolution of the different components and factors during the course. Based on this analysis, it is possible to highlight significant variations between the various phases of the study, especially concerning the factor of Value Components. In Phase 1, participants expressed a more positive perception of the importance of the course contents, as evidenced by the VAT component. In Phase 2, a change in focus was noticed, with the prioritization of obtaining a good grade, as reflected by the EGO component. Finally, in Phase 3, there was again a reorientation of value components, with students demonstrating appreciation for the course topic, as indicated again by the VAT component. Given these results, it is possible to conclude that changes occurred in the different phases of the study, suggesting an evolutionary dynamic in the interests of participants over time.**

***Keywords— Educational technology, Computer-based instruction, Educational software; Theoretical frameworks, Motivation***

## I. INTRODUCTION

Learning to program requires students to develop skills, competencies, and a strong interest or motivation to learn. Analyzing students' motivational factors can help educators plan and implement adequate teaching activities [1, 2].

Studies reveal that motivation arises from the interaction between internal and external factors, incorporating social and emotional dimensions, which adds considerable complexity to this process [2, 3, 4]. Internal or intrinsic factors, such as personal interests, curiosity, and task satisfaction, originate within the individual. On the other hand, external or extrinsic factors are influences, such as tangible rewards, punishments, or social pressures. Furthermore, these factors are interconnected with social dimensions, such as appreciation and recognition, which play a crucial role in student motivation [3]. Feeling valued and recognized for effort and performance can considerably increase learning motivation. The sense of control over one's learning, known as self-efficacy, also significantly influences students' motivation. Students who perceive themselves as capable and confident in carrying out academic tasks tend to engage in learning actively [4, 5].

Emotional factors, such as anxiety, stress, and self-confidence, also significantly influence student motivation. Proper emotional management can promote more positive and lasting motivation for learning [5]. Therefore, understanding the complexity and interaction of these different factors is fundamental to promoting and sustaining student motivation in the educational context.

This study aimed to understand the evolution of students' motivation during an introductory programming course in a computing degree program at a Macao higher education institution and to identify which factors played a more critical role in motivating these students.

Section II presents a brief literature review relevant to the study's topics, while section III describes the methodology

used. Section IV discusses the most significant results, and finally, section V presents the work's conclusions.

## II. Literature Review

Self-determination theory distinguishes between intrinsic motivation, which refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivation, which refers to doing something because it leads to an outcome [6]. Although intrinsic motivation exists within individuals, it occurs in the relationship between individuals and activities, and not all individuals are intrinsically motivated for any task. Thus, intrinsically motivated behaviors, performed out of interest, satisfy the innate psychological needs for competence and autonomy and are the prototype of self-determined behavior. Extrinsically motivated behaviors are performed because they are instrumental to some consequence. They can vary in the extent to which they represent self-determination. Internalization and integration are the processes by which extrinsically motivated behaviors become more self-determined [4].

In social cognitive theory, motivation is understood as goal-oriented behavior, triggered and maintained through expectations about the results of actions and the perception of self-efficacy to carry them out [7]. The most significant aspects of this theory for understanding motivation include perceived self-efficacy, goal setting, consequences, and outcome expectations. Self-efficacy is the personal assessment of one's abilities to carry out activities, or in simpler terms, the belief in one's ability [8, 9].

Motivation is the force that drives, regulates, and sustains individual actions. It is a complex process that influences the initiation and persistence of an activity over time. Rather than being a static characteristic, motivation is dynamic, responding to the nuances of the context in which the individual is inserted [10, 11].

The coexistence of intrinsic and extrinsic motivations is evident in the educational scenario. A student may feel driven by an activity's intrinsic pleasure while being influenced by the external rewards or consequences offered by the social context. This duality reflects the complexity of the motivational process, where the sources of stimulation can be both internal and external, shaping the individual's behavior and experience in the search for knowledge.

Motivation must be understood as a process rather than a product, as it cannot be observed directly but only inferred from the behaviors and effects it produces. It involves goals or objectives that demand physical and mental involvement, where physical involvement includes effort and persistence, while mental involvement includes planning, decision-making, and problem-solving, among others [2]. The motivational process in academic learning is a complex phenomenon highlighted as one of the main aspects that can contribute to student performance [10, 11].

Álvarez et al. identified obstacles to learning and the importance of tools to support self-regulation [12]. Fang and Zhao revealed differences in motivation and learning strategies between American and Chinese engineering students [13]. Marra and Wheeler demonstrated that student-centered approaches promote motivation and engagement in engineering learning [14]. Kuo et al. investigated how self-regulation can contribute to learning in programming, showing that goal-setting and self-efficacy positively influence student performance [15]. Samsuri et al. investigated the increased motivation of first-year engineering students after an introductory course [16], while Chen and Lee developed a mobile cooperative learning environment that integrates different learning styles to improve student motivation [17]. Finally, Haron et al. addressed the self-regulation of learning in engineering students, developing a specific instrument to measure self-regulation in this context [18]. These findings reiterate the importance of promoting student motivation as an essential education component.

The growing interest in research on motivation in learning programming highlights the concern of educators and scholars in this field, as motivation is considered one of the main factors for student success. Previous studies identified correlations between motivation and performance in introductory programming courses, highlighting the need for effective motivational strategies [1]. The association between regulatory and motivational strategies and learning to program emphasizes the importance of self-regulation for academic success [19, 20]. Other studies indicate that self-efficacy and cognitive and affective factors are essential for developing programming skills [21]. Some authors highlight the importance of intrinsic motivation, facilitated by self-directed and constructionist pedagogical methods [22]. Others emphasize the importance of innovative and effective assessments to maintain engagement [23][24]. Motivation is also impacted by students' characteristics and previous experiences [5][25].

Most studies emphasize the importance of approaches that promote student motivation as an essential element for learning success, especially in programming. Learning programming can be challenging due to the complexity of mastering information and the required logical reasoning [26]. The discipline's abstract and highly technical nature can pose significant obstacles for beginners. Overcoming these difficulties requires persistence, practice, and patience to develop the necessary skills gradually.

Therefore, understanding the motivation for learning requires an in-depth analysis of the multiple interconnected factors that motivate students. This involves examining everything from intrinsic factors, such as personal interests and values, to external factors, such as the school environment and social interactions. This research can contribute to developing more appropriate and effective teaching methodologies [10].

Research in real settings highlights the importance of addressing both motivational and cognitive aspects of academic performance [27, 28]. While motivational components include students' perceptions of the learning environment and their personal beliefs, such as goals, self-efficacy, interest, and worth, cognitive components encompass content mastery and a variety of cognitive and metacognitive strategies.

## III. Methodology

The main objective of this study was to identify the factors that influence student motivation throughout the Programming I course at a higher education institution in Macao. We used the motivation section of the Motivated Strategies for Learning Questionnaire (MSLQ), proposed in 1991 by Pintrich and collaborators [29]. The MSLQ is a

theoretical-cognitive instrument used to investigate motivation and the use of learning strategies in university students [13, 29]. It is frequently used to assess how students motivate themselves, regulate their learning, and employ strategies to achieve their educational goals [29, 30, 31].

The MSLQ motivation section includes 31 statements organized into six constructs: Intrinsic Goal Orientation (IGO), Extrinsic Goal Orientation (EGO), Value of Activity (VAT), Control of Learning (COL), Learning Self-Efficacy (LSE), and Test Anxiety (TAX). These constructs are grouped into three factors (Value Components, Expectancy Components, and Affective Components), as indicated in Table 1.

Questions 1, 16, 22, and 24 belong to Intrinsic Goal Orientation, related to students' perception of their reasons for performing a task. Questions 7, 11, 13, and 30, classified as Extrinsic Goal Orientation, relate to grades and rewards [29]. Questions 4, 10, 17, 23, 26, and 27 comprise the Value of Activity, related to the student's perception of the importance and usefulness of the course material. Control of Learning, represented by questions 2, 9, 18, and 25, refers to students' confidence in their learning efforts. Questions 5, 6, 12, 15, 20, 21, 29, and 31 assess Learning Self-Efficacy, which includes expectation of success and self-assessment of the ability to perform a task. Finally, questions 3, 8, 14, 19, and 28 address the Test Anxiety related to anxiety regarding academic performance. The level of agreement with each statement is manifested using a 7-point Likert scale.

The study involved 137 students enrolled in the Programming I course. The MSLQ questionnaire was administered to all students at three different moments: 1) 3 to 4 weeks after the start of the course, 2) after the announcement of the midterm exam grades, and 3) at the end. Only the data from students who responded to the three phases was considered, totaling 92 respondents.

Initially, the data was organized into tables for each phase, establishing the relationship between the MSLQ Components, Constructs, and Statements. Next, Principal Component Analysis (PCA) was applied in each phase to reduce dimensionality and preserve maximum sample variability by transforming correlated variables into uncorrelated principal components [32, 33, 34]. This process simplifies the dataset and facilitates monitoring changes between study phases by creating independent variables that capture the most significant variations. The phase-based study aimed to minimize errors related to the linear relationships among the original variables, as PCA directly addresses these correlations, generating a set of uncorrelated components. After, the factor loadings for each statement concerning the main components of the PCA were extracted.

Using the first two components, as they retain the highest variability, the total contribution of each statement's variability was obtained by adding the respective factor loadings (quality of representation). Statements with high factor loadings have a higher influence on the component.

The analysis focused on identifying significant differences in the variability of factor loadings between phases and for each statement. For this, variability analysis was used with the ANOVA (Analysis of Variance) and the Tukey test to determine which pairs of group means are significantly different from each other and in each of the three phases [34, 35, 36, 37, 38, 39].

TABLE I. MSLQ MOTIVATION SECTION CONSTRUCTS AND STATEMENTS

| | |
|---|---|
| **Value Components** | |
| IGO | 1. In a class like this, I prefer course material that really challenges me so that I can learn new things.<br>16 - In a class like this, I prefer course material that arouses my curiosity, even if it's hard to learn.<br>22 - The most satisfying thing for me in this course is to try to understand the content as thoroughly as possible.<br>24 - When I have the opportunity in this class, I choose course assignments that I can learn from, even if they don't guarantee a good grade. |
| EGO | 7 - Getting a good grade in this class is the most rewarding thing for me right now.<br>11 - The most important thing for me right now is improving my overall grade point average, so my main concern in this class is to get a good grade.<br>13 - If I can, I want to get better grades in this class than most other students.<br>30 - I want to do well in this class because it is important to show my ability to my family, friends, employer or others. |
| VAT | 4 - I think I'll be able to use what I learn in this course in other courses<br>10 - It's important for me to learn the course material in this class.<br>17 - I am very interested in the content area of this course.<br>23 - I think the course material in this class is helpful for me to learn.<br>26 - I like the subject matter of this course.<br>27 - Understanding the subject matter of this course is very important to me. |
| **Expectancy Components** | |
| COL | 2- If I study in appropriate ways, then I will be able to learn the material of this course.<br>9 - It's my own fault if I don't learn the material in this course.<br>18 - If I try hard enough, then I will understand the course material.<br>25 - If I don't understand the course material, it's because I didn't try hard enough |
| LSE | 5 - I believe I will receive an excellent grade in this class.<br>6 - I'm certain I can understand the more difficult material presented in the readings for this course.<br>12 – I'm confident that I can learn the basic concepts taught in this course.<br>15 – I'm confident that I can understand the more complex material presented by the instructor in this course.<br>20 – I'm confident I can do an excellent job on the assignments and tests in this course.<br>21 - I expect to do well in this class.<br>29 - I'm certain I can master the skills being taught in this class.<br>31 - Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class. |
| **Affective Components** | |
| TAX | 3 - When I take a test, I think about how poorly I am doing compared to other students.<br>8 - When I take a test, I think about items on other parts of the test I can't answer.<br>14 - When I take tests, I think of the consequences of failing.<br>19 - I have an uneasy, upset feeling when I take an exam.<br>28 - I feel my heart beating fast when I take an exam. |

The data organization and statistical tests were conducted using the RStudio software in R language, with the packages tidyverse, FactoMiner, Factoextra, and psych [40, 41, 42, 43].

## IV. Results

The data was structured into three tables, each representing a different phase of the study and containing information about the 31 statements in the motivation section of the MSLQ.

### *A. Cronbach's alpha, Bartlett, and KMO metrics*

The preliminary step was to evaluate the internal consistency of the data using Cronbach's alpha, sphericity with Bartlett, and the proportion of data variance with the Kaiser-Meyer-Olkin (KMO) metric. The results show values above 0.76 (average) and 0.90 (almost perfect), indicating the data's fit to the constructs. The Bartlett test indicates the feasibility value for using factor analysis (0) for all tables. The KMO indicates good and very good sampling adequacy (between 0.80 and 0.90).

### *B. Applying PCA*

A principal components analysis (PCA) was performed on data from the three phases to present the information obtained about each component of the Motivation section of the MSLQ: Value Component, Expectancy Component, and Affective Component. PCA offers dimensionality reduction, pattern identification, and result interpretation facilitation.

### *C. Value Components*

The Value Components assess students' willingness to engage in learning activities based on intrinsic interest, extrinsic value, and perceived importance of tasks for their personal goals. Table 2 presents these component statements and the factor loadings obtained through PCA in each phase (Ph1, Ph2, Ph3).

With the data in Table 2, we analyzed variance (ANOVA) and a Tukey's test to examine differences in level of interest between phases. The ANOVA result revealed a statistically significant difference in means ($F = 4.257$, $p = 0.00237$), and the Tukey test indicated statistically significant differences between pairs of means.

Figure 1 illustrates the motivational difference between the phases for the Value Component, suggesting that phase Ph3 has significantly different motivations than the other phases (Ph1 and Ph2). It reveals no significant difference in the mean levels of variance between phases Ph1 and Ph2.

TABLE 2 FACTOR LOADINGS PER PHASE – VALUE COMPONENTS

| Statements Value Components | Ph1 | Ph2 | Ph3 |
|---|---|---|---|
| stat1 | 0,63 | 0,25 | 0,72 |
| stat16 | 0,76 | 0,64 | 0,68 |
| stat22 | 0,73 | 0,59 | 0,41 |
| stat24 | 0,75 | 0,69 | 0,69 |
| stat7 | 0,65 | 0,59 | 0,67 |
| stat11 | 0,68 | 0,74 | 0,53 |
| stat13 | 0,58 | 0,54 | 0,68 |
| stat30 | 0,71 | 0,22 | 0,61 |
| stat4 | 0,62 | 0,57 | 0,59 |
| stat10 | 0,65 | 0,63 | 0,73 |
| stat17 | 0,71 | 0,51 | 0,54 |
| stat23 | 0,80 | 0,70 | 0,74 |
| stat26 | 0,68 | 0,58 | 0,69 |
| stat27 | 0,77 | 0,69 | 0,42 |

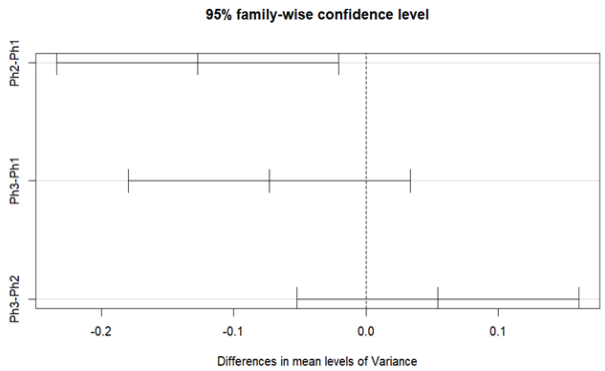


Fig. 1 – Variance between groups of the Value Components

We observed a strong presence of the Value of the Activity Component (VAT) in Phase 1 with an emphasis on the learning process motivated by the positive perception regarding the importance and usefulness of programming, as expressed by statement 23 (*I think the course material in this class is helpful for me to learn),* the interest in the course topics, represented by statement 27 (*Understanding the subject matter of this course is very important to me*), in addition to the intrinsic aspects, such as curiosity and challenge, expressed in statement 16 (*In a class like this, I prefer course material that arouses my curiosity, even if it's hard to learn*). This suggests that students valued their interest in the subject and topics covered in the course.

In Phase 2, students showed attention to aspects of motivation and learning strategies that remained consistent throughout the two phases. The emphasis given to VAT and the interest in the subject remains, as expressed again by statement 27, but also by statement 24 (*When I have the opportunity in this class, I choose course assignments that I can learn from, even if they don't guarantee a good grade*) and 16 (*In a class like this, I prefer course material that arouses my curiosity, even if it's hard to learn*). However, a transition is observed towards an orientation more focused on results and academic performance. This is evidenced by the valorization of the Extrinsic Goal Orientation (EGO) Component and the emphasis given to statement 11 (*The most important thing for me right now is improving my overall grade point average, so my main concern in this class is to get a good grade*). This change may be a consequence of the realization of the mid-term exam, which may have caused students to prioritize improving their general grade average, focusing on obtaining a good grade in the course.

In Phase 3, there is continuity in the patterns regarding the usefulness of the subjects, the importance of learning programming, the preference for challenges conducive to learning, and the choice of work with learning potential, as expressed by statement 10 (*It's important for me to learn the course material in this class*), and 1 (*In a class like this, I prefer course material that really challenges me so that I can learn new things*). However, there is a noticeable change compared to the previous phases, as statements 27 (*Understanding the subject matter of this course is very important to me*) and 22 (*The most satisfying thing for me in this course is to try to understand the content as thoroughly as possible*), previously highlighted, show an apparent reduction. On the other hand, intrinsic motivation emerges by valorizing topics that challenge, awaken curiosity, and contribute to new learning. At this phase, the data suggests that VAT gains even more importance. These results show a

tendency toward decreasing the Value Components during the course, with a slight drop in Phase 2 and a more pronounced drop in Phase 3.

### *D. Expectancy Components*

The Expectation Components are related to learning control and self-efficacy. They address students' confidence in their ability to learn, expectations of success, and ability to perform tasks. Table 3 presents this Component's statements and factor loadings obtained through PCA in each phase (Ph1, Ph2, Ph3).

Analysis of variance (ANOVA) revealed a statistically significant difference in means ($F = 7.303$, $p = 0.00237$). The Tukey test determined that the pairs of means had statistically significant differences.

Figure 2 depicts variations in motivation across phases, indicating that phase Ph3 exhibits notable disparities compared to Ph1 and Ph2 regarding motivation within the Expectation Components.

In Phase 1, we can observe that students reveal a strong expectation of personal responsibility for learning, highlighting the relationship with their ability to manage and control their actions and efforts during learning activities. This is evidenced by the Control of Learning Component (COL), represented by statements 25 (*If I don't understand the course material, it's because I didn't try hard enough)* and 9 (*It's my own fault if I don't learn the material in this course*). Furthermore, there is a very high initial expectation regarding their ability to learn, as indicated by the Learning Self-Efficacy Component (LSE), represented by statement 12 (*I'm confident I can learn the basic concepts taught in this course*).

In Phase 2, the data suggests a qualitative change in expectations regarding controlling activities, demonstrating higher self-confidence in carrying them out. This is evidenced by statements 5 (*I believe I will receive an excellent grade in this class*), 15 (*I'm confident that I can understand the more complex material presented by the instructor in this course*), and 20 (*I'm confident I can do an excellent job on the assignments and tests in this course*). This change indicates that students may have considered factors other than their responsibility, increasing their self-confidence, possibly due to positive mid-term exam results or more facility to understand the content. However, there is still some control over the progress of the course, as revealed by statement 31 (*Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class*).

TABLE 3 FACTOR LOADINGS PER PHASE - EXPECTANCY COMPONENTS

| Statements Expectancy Components | Ph1 | Ph2 | Ph3 |
|---|---|---|---|
| stat2 | 0,70 | 0,53 | 0,59 |
| stat5 | 0,79 | 0,78 | 0,68 |
| stat6 | 0,70 | 0,65 | 0,70 |
| stat9 | 0,81 | 0,42 | 0,69 |
| stat12 | 0,80 | 0,67 | 0,69 |
| stat15 | 0,80 | 0,69 | 0,72 |
| stat18 | 0,67 | 0,57 | 0,42 |
| stat20 | 0,78 | 0,69 | 0,69 |
| stat21 | 0,56 | 0,56 | 0,60 |
| stat25 | 0,83 | 0,32 | 0,56 |
| stat29 | 0,78 | 0,65 | 0,71 |
| stat31 | 0,80 | 0,67 | 0,65 |

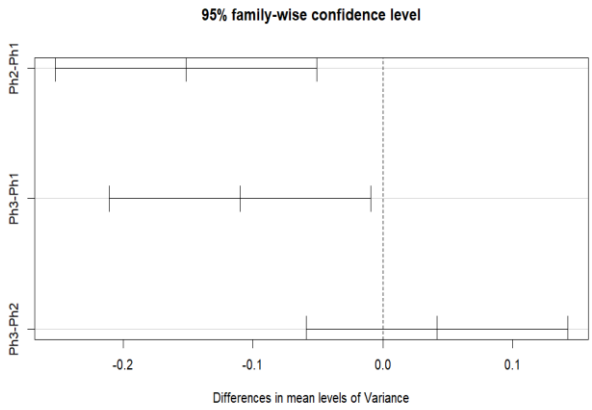


Fig. 2 – Variance between groups of the Expectancy Components

In Phase 3, students are more committed to taking responsibility for their learning, attaching significant importance to controlling the activity and self-regulation for learning. This is evidenced again by statement 15 and by statement 29 (*I'm certain I can master the skills being taught in this class*). Furthermore, some significant changes were observed in the previous phase, especially in the statements related to activity control. For example, statements 15 and 29 present higher factor loadings in Phase 3, which suggests an increase in the importance attributed by students to controlling the activity and self-regulating the learning process.

Considering the Expectancy Components, students' expectations and attitudes toward learning evolve. In Phase 1, there is a strong emphasis on personal responsibility and control for learning, taking responsibility for their learning and successes/failures. In Phase 2, after the mid-term exam, students demonstrate decreased self-confidence in their abilities and expectations regarding academic performance. However, they still maintain some control over the course progress. Finally, in Phase 3, students have regained their confidence and expectations. The data suggests that student expectations varied across the different phases of the study, with a general trend of high expectations in Phase 1, followed by a drop in Phase 2 and a partial recovery in Phase 3.

### *E. Affective Component*

The MSLQ's Affective Component refers to the emotional dimension of motivation to learn. Table 4 presents this component's statements and the respective factor loadings obtained in each phase (Ph1, Ph2, Ph3).

Through ANOVA, it was found that there is no statistically significant difference in the means ($F$ 2.559 =, $p = 0.119$). The Tukey test also identified no statistically significant differences between pairs of group means.

TABLE 4 FACTOR LOADINGS PER PHASE - AFFECTIVE COMPONENTS

| Statements Affective Component | Ph1 | Ph2 | Ph3 |
|---|---|---|---|
| stat3 | 0,68 | 0,52 | 0,84 |
| stat8 | 0,95 | 0,67 | 0,64 |
| stat14 | 0,75 | 0,70 | 0,80 |
| stat19 | 0,87 | 0,69 | 0,81 |
| stat28 | 0,75 | 0,79 | 0,88 |

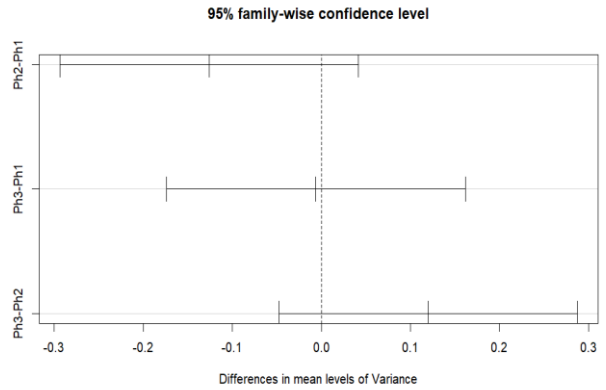


Fig. 3 – Variance between groups of the Affective Components

Figure 3 illustrates variations in motivation across phases, suggesting no significant differences between groups when compared to Ph1, Ph2, and Ph3 regarding motivation within the Affective Component. However, as described, we can highlight changes over time regarding affection, even though these changes were not statistically significant.

In Phase 1, statements 8 (*When I take a test, I think about items on other parts of the test I can't answer*) and 19 (*I have an uneasy, upset feeling when I take an exam*) exhibit an evident emotional charge.

In Phase 2, the increase in statement 28 (*I feel my heart beating fast when I take an exam*) shows the student's perceptions after the mid-term exam. This suggests a persistent concern about exams and an awareness of their emotional impact, even at advanced course stages, although it is weaker than in Phase 1.

In Phase 3, the perception of success concerning the grade and overall average is reinforced, as indicated by statements 28 and 3 (*When I take a test, I think about how poorly I am doing compared to other students*). Statement 8 shows more significant variability compared to Phase 1, while statement 3 has a similar behavior to Phase 2. This indicates consistency in students' emotional experience during exams, regardless of the stage of the course.

In summary, we observed significant variations in the emotional component throughout the different phases of the study. These variations may indicate changes in students' perception and emotional response to the learning environment and academic activities, especially about assessments. The importance of anxiety associated with exams and concern about test items throughout the course is highlighted. This suggests that students maintain constant attention to the practical and emotional challenges of assessments, regardless of the specific phase of the course.

Based on the results of the factor loadings, we can identify that Component 1 is associated with Self-Confidence and Motivation to Learn. This component captured the highest possible variability related to statements from the Value Components and Expectancy Components. Notable among these are statements related to confidence, such as question 12 ("*I am confident that I can learn the basic concepts taught in this course*"), 29 ("*I am certain that I can master the skills being taught in this class*"), and 31 ("*Considering the difficulty of this course, the instructor, and my own abilities, I think I will do well in this class*"), as well as those about the instructional material expressed in question 23 ("*I think the instructional material for this class is useful for me to learn*") and expectations regarding learning demonstrated by questions 21 ("*I hope to do well in this class*") and 22 ("*The most satisfying thing for me in this course is to try to understand the content as deeply as possible*").

The second component can be characterized as Concern and Anxiety regarding performance. Students who fall into this component demonstrate significant concern and anxiety during tests and exams. They tend to feel uncomfortable and worried about the consequences of failure, comparing themselves to other students and experiencing symptoms of anxiety, such as rapid heartbeat. This profile suggests a high emotional sensitivity in evaluation situations, which can affect their performance and well-being during these moments. This is evidenced by statements 19 ("*I feel uncomfortable and upset when taking an exam*") and 14 ("*When taking tests, I think about the consequences of failing*"), indicating discomfort and concern during exams.

## V. Study Limitations

The study has a few limitations. The relatively smaller sample size might limit the generalizability of the findings to other introductory programming courses or student populations. In the future, we plan to conduct a larger-scale study with a more diverse sample across multiple institutions. The study is based solely on self-reported data using the MSLQ, so there is always the potential for bias or inaccuracies in self-reported responses. The MSLQ also focuses on a specific set of motivational factors. Still, other important factors could have influenced student motivation, such as social support, learning environment, or specific instructional methods. The study does not use qualitative data (e.g., interviews, focus groups), which could provide a richer understanding of the students' experiences and motivations behind their responses. Future research could employ mixed-methods research, combining quantitative and qualitative data to provide a more comprehensive understanding.

## VI. Conclusion

Learning is a complex and dynamic process influenced by several elements, such as social context, motivation, and previous experiences. In formal educational environments, knowledge is constructed through the interaction between instruction, the relationship between teachers and students, and pedagogical methodologies.

To investigate possible differences in the variability of responses related to the statements of Value Component, Expectancy Component, and Affective Component, we analyzed the responses of 92 students enrolled in the Programming I course in three distinct phases. We used PCA (Principal Component Analysis) to reduce the complexity of the data and obtain the factor loadings of each variable in each phase. These factor loadings were analyzed using ANOVA and Tukey tests, which identified significant changes in students' response patterns throughout the different phases of the study.

Regarding Value Components, we noticed that students initially showed interest in the practical applicability of the course and in understanding the content. However, there was a shift in focus towards pursuing high grades, indicating possible pressure for academic results. Also, there was a resumption of interest in the usefulness of the course, with

priority given to content that aroused curiosity and challenges.

Regarding Expectancy Components, we observed students' initial solid confidence in their learning ability and personal responsibility for the process. However, this perception seemed to adapt throughout the course, considering other elements beyond individual efforts, such as the learning environment and assessments. This change in perception suggests the importance of pedagogical approaches that recognize the influence of different factors on the learning process.

Regarding the Affective Component, students persistently expressed concern about the perceived difficulty of test questions and the negative emotions associated with assessments throughout all phases of the course. This consistency highlights the importance of approaches that consider academic content and students' emotional support during challenges and assessments.

Based on the data, we concluded that there were variations in participants' motivational perceptions. Although students kept responsibility and control over the learning process, other underlying factors, such as assessments, expectations, interests, and emotional state, triggered significant changes in their perceptions and behaviors throughout the study. This "motivational perception" refers to how individuals interpret and attribute meaning to motivation-related stimuli and situations, including personal goals, rewards, challenges, and expectations. This perception guides people's actions towards specific goals and aspirations, influencing their behavior and choices.

These conclusions highlight the importance of a dynamic and adaptive approach in planning and implementing educational strategies, contributing to a more engaging and adaptive learning environment for Programming students. It is essential to offer content and challenges aligned with the student's level, encourage question formulation, and promote the exploration of multiple approaches and innovative techniques, which can increase creativity and engagement. Appropriate feedback and recognizing the student's improvements and successes can stimulate self-efficacy, a crucial aspect of student motivation. Using real problems to contextualize learning and maintain engagement is also recommended. Finally, to reduce anxiety associated with tests, it is suggested that practices with simulated tests be carried out, constant feedback be offered, reviews be organized, and a welcoming environment be created, in addition to dividing tests into smaller parts to facilitate the students' approach. These practices aim to create a more dynamic, adaptive, and motivating learning environment for studying programming.

Based on the study on value, expectation, and affective components over time, we plan to investigate the relationship between these motivational factors and students' academic performance. This could provide valuable insights into developing educational strategies that promote motivation, leading to better student performance in Programming.

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