Identification of Pre-University Factors that Affect the Initial Motivation of Students in Computing Programs: A multi-institutional case study

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***Abstract*—This Research to Practice Paper presents the results of the evaluation of pre-university factors that impact the initial motivation of undergraduate students in computing. Although there are studies in the literature that have investigated some previous factors, this paper replicates a previous work that aims to consolidate several pre-university factors and, as the main differential, uses the AMS (Academic Motivation Scale), a scale already consolidated in the literature to measure students' initial motivation, and evaluate the relation between motivation and candidate factors. We applied a questionnaire to 159 students from different computing programs in ten universities, which evaluates 20 factors divided into 4 groups: personal and demographic data, taste and knowledge of the program and area, computing experience, and school performance. To evaluate the correlation between factors and motivation, we used Spearman's coefficient, t-student test, and ANOVA to evaluate the correlation between factors and motivation. As main results, we found significant variation in the initial motivation according to following factors: taste for programming and technology, knowledge about the undergraduate program content, correct perception about computing professionals, knowledge and experience in computer programming, and general school performance.**

Keywords—motivation, software engineering education, student dropout

I. INTRODUCTION

High demand for professionals in computing contrasts with the low demand for courses in the area and with the low index of students who successfully finish their studies. One of the factors considered important and directly related to the success of the students is their initial motivation. Similarly, many aspects prior to student admission in the course are considered important for academic success.

It is believed that these aspects related to previous moments of students entering the university, such as the knowledge of the area, the experience with computing/programming and the previous performance in math, can also be worked by the computing area. These are factors that can impact on the motivation, engagement, and success of the students. So, many initiatives have been developed seeking to the inclusion of computer education in basic education, logic development, problem-solving, etc.

However, few papers in the field of computing have investigated the impact of these pre-university factors with the initial motivation of the students. Similarly, no instrument was found seeking to identify these factors, neither their relationship with the motivation of the students.

In a previous work [Anonymous, 2017] it was investigated factor that affects initial motivation in a specific bachelor in software engineering program. In this context, this paper aims to evaluate the impact of pre-university factors on the initial motivation of students of several different computing programs and universities. In order to achieve this goal, six research questions were drawn up as follows:

RQ1 – Personal data (gender and age) and the way of entering in the program are related to the initial motivation of the students?

RQ2 – Is the taste for computing related to the initial motivation of first-year students in computing?

RQ3 – Is the knowledge of the program and the area related to the initial motivation of first-year students in computing?

RQ4 – Is previous experience with computing related to the initial motivation of first-year students in computing?

RQ5 – Is the previous school performance related to the initial motivation of first-year students in computing?

RQ6 – Is the context (university and program) related to the initial motivation of first-year students in computing?

RQ7 – What are the main reasons why first-year students choose programs in the area of computing?

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This paper is divided as follows: i) in section 2 a contextualization of motivation and state of the art is presented; ii) in section 3, the methodology used is described; iii) in section 4 the results are presented; iv) in section 5, the results are discussed; v) the conclusions of the work are presented in section 6.

II. RELATED WORKS

Several studies have been trying to identify risk factors for low retention and low success rates in computing programs and courses, including knowledge in computing and prior experience, in addition to the student's potential and performance in high school [*1*].

In this context, the previous or pre-university factors are investigated by some papers and can be divided into three groups:

- Knowledge of the area and course: a broad and social vision of the area, taste by the area of technology, the image of the area and IT professionals, knowledge of the nature of the course, understanding about the nature of computing, computing in basic education [*2*] [*3*];
- Computing/Programming experience: work experience in the field, previous knowledge in computing [*4*] [*5*] [*6*] [*2*] [*3*] [*7*] [*8*];
- Previous performance: educational history, systemic vision, knowledge of mathematics [*9*] [*6*] [*7*].

However, from these works only four [*5*] [*2*] [*7*] [*10*] perform a case study and a systematic analysis to prove or not their hypothesis. Regarding some factors such as "experience", "prior knowledge", "learning", and "participation" there are differences among studies. For example, the "experience" factor, was evaluated by three studies, one of them with a strong impact proven [*8*], another with weak impact [*4*], and a third with no impact [*6*].

Moreover, none of the previous works found uses a specific instrument that includes all the pre-university factors mentioned, according to factors cited by review of the literature [Anonymous, 2018]. Therefore, the differential of this work is its application to students from different universities in order to assess whether the context influences the results. In addition, another differential is the use of a scale already consolidated to identify the motivating factors and also the level of motivation itself.

III. RESEARCH METHOD

The proposed study is based on the application of a questionnaire (survey) to 159 first-year students of computing programs in 10 different universities. The survey was applied during the second semester of 2017. The development and implementation of this survey were based on the process described by [*11*].

The questionnaire for identifying the previous factors was based on an earlier work [*12*], which defined the instrument based on a synthesis of literature factors. For this work, minor improvements and adaptations were made, according to the needs identified in the original work.

TABLE I. QUESTIONNAIRE GROUPS AND FACTORS

Group	Factor
1. Personal and demographic data	1A – Gender 1B – Quota 1C – Entrance exam position 1D – Year of entrance 1E – Age 1F – Way of entering
2. Taste and knowledge of the area	2A – Taste for programming and technology 2B – Knowledge about the undergraduate program goals 2C – Knowledge about the undergraduate program content 2D – Correct perception about computing professionals
3. Computing and programming experience	3A – Knowledge, and experience in computing 3B – Knowledge, and experience in computer programming 3C – Programming experience in high school
4. Prior school performance	4A – General school performance 4B – Prior math performance
5. Initial Motivation	5A – Intrinsic motivation 5B – Extrinsic motivation 5C – Self-realization 5D – Social motivation 5E – Amotivation or lack of motivation

The questionnaire is divided into five groups and 20 factors, as shown in Table I. Each item has options following a Likert scale of 5 points.

In addition to these factors, we apply the AMS scale [*12*] to measure the motivation of the students. The original version of the scale was developed in Canadian French (L'échelle of motivation in Éducation-EME) by [*12*] assuming the multifactored motivational processes. It is composed of 28 items and punctuated on a Likert scale with seven points. EME was subsequently translated into English, originating the AMS (Academic Motivation Scale) [*13*]. A Portuguese version was translated and validated by [*14*].

The theoretical or structural factorial model of EME and AMS presents the intrinsic motivation in the form of the subscales: intrinsic motivation - knowledge (IMK), intrinsic motivation - accomplishment (IMA) and intrinsic motivation - stimulation (IMS). In addition to the subscale of amotivation (AMO), the model also contains three other subscales that group the various forms of extrinsic motivation: identify regulation (EMId), introjected regulation (EMIn) and external regulation (EMER) [*13*]:

1) Intrinsic Motivation - Knowledge (IMK): the student engages in activities focused on learning, learning for pleasure, and satisfaction arising from exploring or understanding something new;

2) Intrinsic Motivation - Accomplishment (IMA): accomplishing or creating something, surpassing the known limits, producing satisfaction and pleasure, leading the student to engage in the activities;

3) Intrinsic motivation - Stimulating (IMS): the student invests in activities in order to experience the stimulating and challenging sensations of sensorial or aesthetic nature;

4) Extrinsic Motivation – Identified Regulation (EMId): the student has a reasonable level of perception of the importance of his actions and acceptance of his own responsibility, involving himself with a greater degree of participation and less sense of pressure/external control;

5) Extrinsic Motivation – Introjected Regulation (EMIn): it is based on external contingencies, being controlled by external pressures, such as implied offers of aggrandizement or implied threats of embarrassment. The student acts according to certain standards or expectations, aiming to avoid constraints that generate guilt, shame or seeking positive self-assessment;

6) Extrinsic Motivation – External Regulation (EMER): the student feels pressured by others to act in a certain way. This pressure manifests itself in the form of expectations of reward or concrete or objective punishment;

7) Amotivation (AMO): there is no interest or inspiration, fostered internally or externally, so that the student acts towards an academic objective, manifesting indifference or disinterest.

To identify the type of motivation of students, we use statistical tests to verify the relationship between the variables and the type of motivation, according to the AMS scale. To measure the intensity of motivation in general, facilitating the interpretation and analysis of the results, we calculated a motivation index based on the AMS subscales, grouped in intrinsic motivation, extrinsic motivation, and amotivation.

$$MI = (\Sigma IMK + \Sigma IMA + \Sigma IMS)/3 + (\Sigma ER + \Sigma IR + \Sigma IdR)/3 - \Sigma AM$$

Where:

MI = Motivation index

ΣIMK = Sum of intrinsic motivation – knowledge

ΣIMA = Sum of intrinsic motivation – accomplishment

ΣIMS = Sum of intrinsic motivation – stimulation

ΣER = Sum of external regulation

ΣIR = Sum of introjected regulation

ΣIdR = Sum of identified regulation

ΣAM = Sum of amotivation

For statistical analysis, we used: comparison of means for different levels of one factor (ANOVA – one way) and quantitative data correlation (Pearson's Coefficient and Pearson's chi-square test). The reliability of the questionnaire is measured by Cronbach's alpha coefficient, which measures the internal consistency. As a result, we found that the questionnaire can be considered reliable (Cronbach's alpha of pre-university factors = 0.7816, Cronbach's alpha of AMS = 0.9522 and Cronbach's alpha of whole questionnaire = 0.9421).

IV. RESULTS

In total, 159 students from 10 universities participated in the research, being 5 public universities and 5 private universities, belonging to the following programs: Computer Science, Software Engineering, Information Systems, Analysis in Development of Systems, Systems for the Internet, and Information and Communication Technology. More than 80% of the respondents belong to 5 universities, according to Table II.

TABLE II. RESPONDENTS BY UNIVERSITY

University	Type	Students	%	Program
University A	Public	39	24.5%	Software Engineering
University B	Public	28	17.6%	Information and Communication Technology
University C	Public	27	17.0%	Computer Science
University D	Private	26	16.4%	Information Systems
University E	Public	18	11.3%	Computer Science
University F	Private	6	3.8%	Information Systems
University G	Public	5	3.1%	Systems for the Internet
University H	Private	5	3.1%	Information Systems
University I	Private	3	1.9%	Computer Science
University J	Private	2	1.3%	Analysis in Development of Systems

We have identified that, in general, the students had greater motivation in the subscales: external regulation, introjected regulation, and intrinsic motivation – accomplishment, according to Table III.

TABLE III. MOTIVATION BY SUBSCALE

Subscale	Mean	SD
Amotivation	5.534	3.086
External regulation	15.654	4.519
Introjected regulation	15.622	4.252
Identified regulation	12.377	4.907
Intrinsic motivation - knowledge	11.251	4.208
Intrinsic motivation - accomplishment	15.691	4.093
Intrinsic motivation - stimulation	13.037	4.486

A. *RQ1 – Personal data (gender and age) and way of entering in the program are related to the initial motivation of the students?*

Of the respondents, 86% were male, and 14% female. Most of the respondents entered by university exam (*vestibular*) (34%) and national high school exam (ENEM) (57.9%). The average age of the respondents is 21.9 years. Little more than half (50.9%) was classified in the first-call and 29.5% are selected by quota, primarily by public school quota or social criterion quota (24.5%).

In order to answer the first research question (RQ1), we analyzed the correlation between the demographic data (gender and age), student input data (way of entering, quota, and entrance exam position), and each subscale of the initial motivation.

Table IV presents the analysis according to the gender. Although we perceived a greater level of motivation for men, we could not statistically prove this variation, both in the analysis of the motivation index and subscales.

TABLE IV. RESULTS ACCORDING TO GENDER

	Female (n=22)		Male (n=137)		p-value
	Avg	*t*	*Avg*	*t*	
Motivation Index	19.969	9.688	22.725	7.404	0.124
Amotivation	5.863	4.246	5.481	2.875	0.592
External regulation	15.000	4.265	15.759	4.565	0.466
Introjected regulation	12.045	5.075	12.430	4.897	0.734
Identified regulation	14.363	5.350	15.824	4.036	0.135
Intrinsic motivation - knowledge	14.363	4.884	15.905	3.931	0.101
Intrinsic motivation - accomplishment	11.954	5.028	13.211	4.388	0.224
Intrinsic motivation - stimulation	9.772	4.888	11.489	4.058	0.076

We checked the correlation between age (how years old are each student) and each motivation subscale (Table V). According to [*15*], a correlation is considered significant when the absolute value of the correlation is greater than 0.29. Thus, we found no correlation between age and initial motivation.

TABLE V. CORRELATION BETWEEN AGE AND MOTIVATION SUBSCALES

Subscale	Age
Motivation Index	-0.059
Amotivation	-0.144
External regulation	-0.222
Introjected regulation	-0.174
Identified regulation	-0.172
Intrinsic motivation - knowledge	-0.032
Intrinsic motivation - accomplishment	-0.022
Intrinsic motivation - stimulation	0.020

To fill the program vacancies, the university offers admission accordingly to the candidates' admittance grade. We call this process as entrance exam position. Initially, some candidates are approved considering the classification order. If at least one of those candidates does not enroll, the university makes a new admission offer for each vacancy remaining. This is repeated until all vacancies are filled, or when the waiting list is empty.

TABLE VI. MOTIVATION BASED ON ENTRANCE EXAM POSITIONS

	First (n=81)	Second (n=48)	Other calls (n=24)	Does not apply (n=6)	p-value
Motivation Index	23.427	21.576	20.902	19.611	0.310
Amotivation	5.605	5.458	5.542	5.167	0.985
External regulation	16.247	14.917	15.042	16.000	0.372
Introjected regulation	12.753	11.875	12.500	10.833	0.666
Identified regulation	16.395	14.854	15.083	13.500	0.105
Intrinsic motivation - knowledge	16.358	15.458	13.875	15.833	*0.069*
Intrinsic motivation - accomplishment	13.568	12.833	12.125	11.167	0.355
Intrinsic motivation - stimulation	11.778	11.167	10.708	7.000	**0.049**

In relation to the entrance exam position, although the students who entered in the first call had higher levels of motivation, we could not statistically prove this variance, except for the subscale "Intrinsic motivation – stimulation" (Table VI).

In the studied programs there were basically two ways of entering: *vestibular* or university entrance exam, a test applied by each institution that allows access to a number of students sorted by their final grade, and the National High School Exam (ENEM), applied throughout the national territory by the Brazilian Federal Government to those that are concluding high school. This exam allows the enrollment of other candidates sorted by their final grade. The exceptions are classified in this work as others way of entering (analysis of history, high school grade).

In relation to the way of entering, we identified that in general students who entered through the vestibular had higher rates of motivation, while students who did not enter via *vestibular* or ENEM had a lower motivational rate. However, we found significant variance only for the subscales "Introjected regulation" and "Intrinsic motivation – stimulation", as shown in Table VII.

TABLE VII. MOTIVATION BASED ON THE WAY OF ENTRANCE

	ENEM (n=92)	Vestibular (n=54)	Other (n=13)	p-value
Motivation Index	22.449	23.080	17.666	0.431
Amotivation	5.760	5.500	4.076	0.183
External regulation	15.652	16.129	13.692	0.219
Introjected regulation	12.402	13.388	8.000	**0.0015**
Identified regulation	15.695	16.037	13.384	0.126
Intrinsic motivation - knowledge	16.173	15.185	14.384	0.181
Intrinsic motivation - accomplishment	13.239	13.407	10.076	**0.0437**
Intrinsic motivation - stimulation	15.652	16.129	13.692	0.219

In Brazilian public universities, there are some reserved vacancies or quotas to specific social and ethnic groups. With respect to quotas, we found no significant variance, as shown in Table VIII.

TABLE VIII. MOTIVATION BASED ON QUOTA

	No (n=112)		Yes (n=47)		p-value
	Avg.	*t*	*Avg.*	*t*	
Motivation Index	22.321	7.548	22.397	8.402	0.956
Amotivation	5.60	3.002	5.361	3.306	0.649
External regulation	15.785	4.317	15.340	5.005	0.572
Introjected regulation	12.232	4.924	12.723	4.902	0.566
Identified regulation	15.625	4.042	15.617	4.761	0.991
Intrinsic motivation - knowledge	15.803	4.037	15.425	4.256	0.597
Intrinsic motivation - accomplishment	13.098	4.236	12.893	5.078	0.794
Intrinsic motivation - stimulation	11.241	4.206	11.276	4.256	0.961

B. *RQ2 – Is the taste for technology related to with the initial motivation of first-year students in computing?*

The students answered about how much they like games, hardware, and programming. Most students have confirmed that they like and use games (86.8%), like hardware and equipment (72.3%), and like programming (65.4%). In general, the more intense the taste of the three areas, the higher the rates of motivation. Table IX shows a summary of the analysis of variance, identifying in bold the significant variances.

TABLE IX. MOTIVATION BASED ON TASTE FOR COMPUTING

	Games	Hardware	Programming
Motivation Index	**0.0403**	**0.000279**	**0.00147**
Amotivation	0.586	0.345	0.937
External regulation	**0.0225**	0.15	0.269
Introjected regulation	0.257	0.0539	0.0985
Identified regulation	**0.0004**	**0.00033**	**0.00815**
Intrinsic motivation - knowledge	**0.0067**	**0.00412**	**0.00008**
Intrinsic motivation - accomplishment	0.108	**0.0143**	**0.00053**
Intrinsic motivation - stimulation	**0.0242**	**0.0008**	**0.00018**

C. *RQ3 – Is knowledge of the course and area related to the initial motivation of first-year students in computing?*

Regarding the knowledge about the program and the area, the students answered about their perception of knowledge about: the objectives and differentials of the program, the content of the program (curriculum), and the job market (Table X).

TABLE X. MOTIVATION BASED ON KNOWLEDGE ABOUT THE PROGRAM

	Course objectives and differentials	Course contents	Job market
Motivation Index	0.085	**0.003**	**0.001**
Amotivation	**0.022**	0.425	0.165
External regulation	0.775	0.360	0.273
Introjected regulation	0.345	**0.003**	**0.028**
Identified regulation	0.103	**0.022**	**0.005**
Intrinsic motivation - knowledge	**0.070**	**0.018**	**0.013**
Intrinsic motivation - accomplishment	**0.008**	**0.000**	**0.000**
Intrinsic motivation - stimulation	0.775	**0.0135**	**0.003**

D. *RQ4 – Is previous experience in computing related to the initial motivation of first-year students in computing?*

We searched to relate the experience and prior knowledge of the student in computer science and general computing, programming, and programming in high school with the initial motivation (Table XI).

TABLE XI. MOTIVATION BASED ON PRIOR EXPERIENCE

	Experience in computing	Programming in high school	Experience in programming
Motivation Index	0.080	0.218	**0.001**
Amotivation	0.124	0.200	**0.009**
External regulation	0.126	0.293	0.089
Introjected regulation	0.135	0.082	**0.043**
Identified regulation	0.128	0.512	**0.004**
Intrinsic motivation - knowledge	**0.015**	0.335	**0.016**
Intrinsic motivation - accomplishment	**0.023**	0.573	**0.011**
Intrinsic motivation - stimulation	0.121	0.355	**0.044**

We found significant variances mainly in "experience in programming". An interesting fact is that students who report having a lot of experience with software development have fewer levels of motivation than others (Table XII).

TABLE XII. MOTIVATION BASED ON PROGRAMMING EXPERIENCE

	1 (n=64)	2 (n=37)	3 (n=31)	4 (n=15)	5 (n=12)	p-value
Motivation Index	21.677	21.360	25.290	26.622	15.972	**0.001**
Amotivation	5.703	4.648	5.483	4.933	8.250	**0.009**
External regulation	15.953	14.351	16.387	17.400	14.000	0.0891
Introjected regulation	12.031	11.702	14.161	13.866	9.833	**0.0432**
Identified regulation	15.765	14.432	17.000	17.466	12.666	**0.004**
Intrinsic motivation - knowledge	15.218	14.594	17.354	17.533	15.000	**0.015**
Intrinsic motivation - accomplishment	12.203	12.432	14.741	15.533	11.833	**0.010**
Intrinsic motivation - stimulation	10.968	10.513	12.677	12.866	9.333	**0.044**

E. *RQ5 – Is the previous school performance related to the initial motivation of first-year students in computing?*

Students evaluated their perception of their general performance in high school and their performance in math. Table XIII shows the relationship between these factors and the initial motivation.

TABLE XIII. MOTIVATION BASED ON PRIOR SCHOOL PERFORMANCE

	Math performance	General performance
Motivation Index	0.178	**0.009**
Amotivation	0.166	0.508
External regulation	0.75	**0.031**
Introjected regulation	0.252	0.146
Identified regulation	0.294	**0.008**
Intrinsic motivation - knowledge	**0.044**	**0.001**
Intrinsic motivation - accomplishment	0.056	**0.002**
Intrinsic motivation - stimulation	0.209	0.092

In general, students with better performance perceptions have better levels of initial motivation. However, for performance in math, we only found significant variance in subscale "Intrinsic motivation – knowledge". For overall performance, in 4 of the 7 scales, we found significant variance.

F. *RQ6 – Is the context (university and program) related to the initial motivation of first-year students in computing?*

In order to verify whether the context can impact on the initial motivation of the students, we analyzed the variance of motivation for different universities, programs, and type of university (public or private).

Table XIV shows that we have found significant variance only in the "Intrinsic motivation – knowledge" subscale, both in relation to different universities and programs.

TABLE XIV. MOTIVATION BASED ON UNIVERSITY AND TYPE OF PROGRAM

	University	Program
Motivation Index	0.710	0.100
Amotivation	0.642	0.940
External regulation	0.356	0.085
Introjected regulation	0.836	0.634
Identified regulation	0.315	0.062
Intrinsic motivation - knowledge	**0.002**	**0.000**
Intrinsic motivation - accomplishment	0.811	0.245
Intrinsic motivation - stimulation	0.852	0.543

The difference occurred basically in 2 public universities and their two respective programs. According to Table XV, University A and University B have students with a lower level of intrinsic motivation – knowledge.

TABLE XV. MOTIVATION BASED ON UNIVERSITY

University	Type	Motivation	SD	n
University A	Public	14.71795	4.495312	39
University B	Public	12.85714	5.197680	28
University C	Public	17.03704	2.192320	27
University D	Private	16.69231	3.608537	26
University E	Public	16.72222	2.886185	18
University F	Private	17.16667	2.228602	6
University G	Public	17.60000	3.286335	5
University H	Private	17.20000	3.701351	5
University I	Private	18.33333	1.527525	3
University J	Private	17.00000	2.828427	2

Analyzing the variance between public and private universities, we found a significant difference in two subscales (External regulation and Intrinsic motivation – knowledge), although in most of them the levels of initial motivation of students in public universities were smaller than students in private universities (Table XVI).

TABLE XVI. MOTIVATION BASED ON THE TYPE OF UNIVERSITY

Subscale	Private	Public	p-value
Motivation Index	23.746	21.840	0.174
Amotivation	5.476	5.556	0.887
External regulation	16.905	15.205	**0.036**
Introjected regulation	12.358	12.385	0.975
Identified regulation	16.619	15.265	0.077
Intrinsic motivation - knowledge	16.952	15.240	**0.020**
Intrinsic motivation - accomplishment	13.048	13.034	0.987
Intrinsic motivation - stimulation	11.786	11.060	0.339

G. *RQ7 - What are the main reasons why first-year students choose programs in the area of computing?*

We can observe in Table Table XVII that, in addition to the intrinsic reasons (interesting in learning, taste for the area), the prospect of a professional future has significant importance for students to choose the computer programs.

TABLE XVII. ANSWERS PER REASONS TO ATTEND

Reasons to attend	Negative	Neutral	Positive
Interest in learning more about computing	5.0%	15.7%	79.2%
To like and feel that the computing area is interesting	6.3%	18.9%	74.8%
Challenges that computing activities promote	25.8%	27.0%	47.2%
Challenge to get through and succeed in the course. Professional challenge	27.7%	24.5%	47.8%
Parental influence	72.3%	19.5%	8.2%
Influence of friends, teachers or other people	60.4%	20.8%	18.9%
Family or social pressure to attend a higher education program	77.4%	11.3%	11.3%
Career and employment perspective	4.4%	13.2%	82.4%
To be the one or one of the few program options for the current reality	65.4%	20.8%	13.8%
Have not passed in another course that was desired	83.0%	7.5%	9.4%

Comparing the motivational index with the reasons for choosing the course, we identified that students who had higher levels of initial motivation had the following reasons: "Interest in learning more about computing" (8.91×10^{-9}), "To like and feel that the computing area is interesting" (8.05×10^{-8}), "Challenges that computing activities promote" (1.57×10^{-8}), "Personal challenge in getting through and achieving success in the course" (2.61×10^{-10}) and "Career and employment perspective" (3.83×10^{-8}).

V. DISCUSSION

Regarding RQ1, we found no significant variance in the rate of motivation according to gender, age, quota, way of entering, and entrance exam position. However, we have identified that students who entered by the first call had intrinsic motivational – stimulation levels greater than others, and also that students who entered through the vestibular exam had levels of

motivation (Introjected regulation and Intrinsic motivation – accomplishment) higher than the others.

Regarding RQ2, we have identified that the taste for the area, both of hardware, games, and software development, is related to the levels of initial motivation, mainly in the subscale "Identified regulation" and all kinds of intrinsic motivation.

Regarding RQ3, we found significant variance in the levels of motivation according to the knowledge of the content of the program and the labor market. We found no significant variance for the knowledge of the objectives and differentials of the program, although students who claimed to have greater knowledge in this respect had higher levels of intrinsic motivation and lower levels of amotivation.

With respect to RQ4, we found significant variance in the motivation index only for the programming experience factor. However, interestingly, students who claimed to have greater and lesser knowledge had lower levels of motivation. We found no significant variation of motivation according to the fact that students had computing in basic education, nor with their general knowledge in informatics, although students who indicated to have higher knowledge in informatics had higher levels of intrinsic motivation.

With regard to RQ5, we identified that students with better general school performance had higher levels of initial motivation, mainly intrinsic motivation. On the other hand, we found no significant variation of motivation levels according to math performance, except for the higher level of "Intrinsic motivation – knowledge" in students with better math performances.

Regarding RQ6, we do not find a relationship between the level of motivation and the university or program. However, we have identified that students from 2 universities (University A and university B) had significantly lower levels of "Intrinsic motivation – knowledge". In addition, we found that students from private universities had higher levels of motivation, although we have found significant variance only for the subscales of "External regulation" and "Intrinsic motivation – knowledge".

Regarding RQ7, we identified that the main reasons for students to choose programs in computing were: career and employment perspective, interest in learning and taste for the area.

In summary, Table XVIII shows the results of each factor in relation to the impact on the motivation index and a comparison to results found in a previous study performed in 2016 and 2017 with 64 freshmen students of only one university [*12*]. The differences found between studies can be due to the different way to measure and calculate the motivation index in each study and can indicate that different context in distinct universities can influence the results.

TABLE XVIII. RELATION BETWEEN FACTORS AND MOTIVATION INDEX

Group	Factors	Motivation Index [a]	Previous Study [*12*]
1. Personal and demographic data	1A – Gender	ND	ND
	1B – Quota	ND	ND
	1C – Entrance exam position	ND	ND
	1E – Age	ND	ND
	1F – Way of entering	ND	ND
2. Taste and knowledge of the area	2A – Taste for programming and technology	D	ND
	2B – Knowledge about the undergraduate program goals	ND	ND
	2C – Knowledge about the undergraduate program content	D	ND
	2D – Correct perception about computing professionals	D	ND
3.Computing and programming experience	3A – Knowledge, and experience in computing	ND	D
	3B – Knowledge, and experience in computer programming	D	ND
	3C – Programming experience in high school	ND	D
4. Prior school performance	4A – General educational performance	D	ND
	4B – Prior math performance	ND	ND

[a] ND – No significant difference / D – Significant difference

VI. CONCLUSION

This paper evaluated the impact of 14 pre-university factors on the initial motivation of first-year computing students, divided into 4 groups: personal and demographic data, taste and knowledge of the area, computing and programming experience, and prior school performance.

The motivation was measured using the AMS (Academic Motivation Scale), which assesses and divides the motivation into 3 groups and 7 subscales: amotivation, intrinsic motivation (knowledge, accomplishment, and stimulation) and extrinsic motivation (external regulation, introjected regulation, and identified regulation).

As a result, we have identified that the demographic data and the way of entering at the university had no significant relation with the motivation rate. Besides these, we found no significant variation of initial motivation according to the knowledge of the objectives and differentials of the program, previous experience in computing, experience with computing at school, and performance in math.

On the other hand, we found a significant variation of the initial motivation according to taste for the area (games, hardware, and software development), knowledge of the program content, knowledge of the area's job market, previous experience in programming, and general school performance. It was interesting to identify that students with greater programming experience have lower levels of initial motivation.

We also identified that the main reasons for students to choose computing programs are related to the perspective of employment and career, interest in learning and taste for the area. With regard to the motivation subscales, we have identified that

students had a higher level of motivation in external regulation, introjected regulation, and intrinsic motivation – accomplishment. The lowest level of motivation was in intrinsic motivation – knowledge.

These results indicate that, for the sample used, despite the taste and knowledge of the area is the group with the greatest impact on the initial motivation, the first-year students in computing are widely extrinsically motivated, with emphasis on the concern with career and professional future. On the other hand, students who already have more experience in computing are less motivated, which may indicate a need for professional qualification for people already positioned in the job market, but they do not have the same initial excitement of the others.

There are some threats to the validity of this research: i) the limited number of participants; ii) other factors not considered in the study that may have impacted on the results; iii) the student self-assessment allows bias in responses according to the student's current state of mind.

Therefore, it is important to conduct more and new studies to better assess the impact of these factors on students to confirm or not the results found in this study. As future work, we intend to monitor the impact of these factors and the motivation variation over time, verifying the correlation with student's performance and dropout.

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