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MOTIVATION TO LEARN NATURAL SCIENCES IN THE CONTEXT OF A TRAINING OF TEACHERS COURSE

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Abstract

The present research verified the role motivational factors play in the learning process, using an undergraduate Natural Sciences course. The overall aim was to evaluate the motivation of these students, determine if motivation varied with the number of years of university attended and identify which motivational factors influence the learning of Natural Sciences. In total, 73 students, during different course offerings from 2012 to 2017, participated in the research, which corresponded to 56.5% of the total enrollment from that time frame. A questionnaire, which was organized into two parts, was employed for data collection, and scored using the Likert scale. In the first part, the following motivational factors were assessed: intrinsic motivation, self-determination, career motivation, self-efficacy and grade motivation. In the second part, the teaching strategies and activities utilized during the course were evaluated with regards to their motivational character. It was found that a majority of students were motivated and that the level of motivation increased throughout the course, being driven by intrinsic factors, that indicated that the students were trying harder to learn scientific concepts, rather than seeking approval and rewards. Furthermore, it was found that participation in projects was the most motivational activity, followed by the academic week and internships.
Keywords: *career motivation, motivational factors, motivation for grades, students self-determination, self-efficacy.*

Introduction

The motivation to learn and acquire scientific knowledge is a topic of interest for researchers and professionals committed to the intellectual, professional and/or personal development of students. As pointed out by Severo and Kasseboehmer (2017a, p. 95), "*motivation can be considered a necessary construct for the impulse of individuals so that to decide to carry out activities or tasks throughout their existence*".

In recent years, research investigating the influence of motivation on learning has been gaining momentum, especially with regards to teaching science, at every educational level. In general, the results of these studies indicate that there is a relationship between motivation and the learning process, and that one may influence the other (Cicuto & Torres, 2016; Mitchell Jr., 1992; Pintrich, 2003; Wang & Reeves, 2007; Wilke, 2003). Thus, motivation appears to

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be an important aspect of learning, since the quality and intensity of the student's participation depends on it (Severo & Kasseboehmer, 2017b).

Motivation is associated with the effort, intensity, time, emotions, and feelings that take place during the teaching-learning process. Therefore, through studies on this topic, it is possible to investigate the involvement of students in didactic activities and social relations established in the classroom (Brophy, 2004; Weinstein, 2014).

The motivation to learn is influenced by several factors and is not the sole responsibility of the students. It should also involve the academic environment (teachers, colleagues, and technicians) and their functioning system, as well as family and friends. In other words, the motivation to learn is influenced by both extrinsic and intrinsic factors. This is a particularly interesting characteristic, since the quality of the experience and performance may be different when students are extrinsically or intrinsically motivated (Ryan & Deci, 2000), and being able to differentiate between them is essential for research on the subject.

Extrinsic motivational factors are based on a system of rewards and punishments (Pozo & Crespo, 2009). Brophy (2004) classified this type of motivation in terms of short and long-term goals. For example, achieving good grades, earning money from their parents and receiving praise and awards from the teacher are examples of short-term goals. On the other hand, being awarded scholarships and securing a high-paying job are examples of long-term goals.

Intrinsic motivational factors are related to the involvement of the student in academic activities, because the student finds these activities challenging, interesting and/or useful for mastering of scientific concepts (Pintrich et al., 1991). There are indications that students motivated to learn through intrinsic factors engage themselves in the activities because they consider them interesting and engaging. It is more important for them to learn than just pass a subject. There is intrinsic motivation when a person engages in a given activity without any external reward or pressure (Guimarães et al., 2002; Pozo & Crespo, 2009).

Another motivational aspect is self-determination, which is when a person voluntarily performs an action. Based on the Self-Determination Theory, Severo and Kasseboehmer (2017a) evaluated the motivational profile of 376 chemistry students, from three high schools, towards the goal of identifying factors that may contribute to the profile. The authors described six possible motivational levels that constitute a continuum of self-determination. It begins with amotivation, passes through four types of regulation (external, introjected, identified, integrated) and, finally, reaches intrinsic motivation. The results indicated that the students, of the three schools, presented a motivational profile that was predominantly integrated regulation, meaning that the students were motivated and wanted to learn Chemistry, because of the interest and perceived importance of this knowledge, both in a professional as well as personal sense. Furthermore, family, external rewards and laboratory-based classes were highlighted as factors that can influence the motivation of the students, positively or negatively.

The study of Tuan et al. (2005) analyzed self-efficacy and the value of scientific learning as motivational factors for student learning. Regarding self-efficacy, this can be an indicator of the students' commitment since they are more engaged in activities in which they feel competent and confident than in those in which this does not occur. In this context, the previous work of Pajares (1996) investigated the influence of self-efficacy in the development of academic works and showed that people with low self-efficacy perceive tasks to be more complex than people without low self-efficacy. Regarding the value of scientific learning, this is a motivational factor that begins with students becoming actively involved in scientific learning and occurs when they realize the importance of the tasks.

The work of Cicuto and Torres (2016) analyzed the motivation of students to learn Biochemistry through active teaching methods, using a study that involved study periods and discussion groups. The results indicated that students who participated in this active learning teaching strategy presented higher levels of intrinsic motivation, self-efficacy, and an enhanced

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value of scientific learning. The authors emphasized that partaking in student-centered activities increased the motivation of the study participants (Cicuto & Torres, 2016).

Furthermore, the research developed by Wilke (2003) evaluated the effect of active learning strategies in student achievement, motivation, and self-efficacy during a Human Physiology course. The results showed that the students who participated in the active strategies acquired significantly more knowledge and were more self-efficacious than the students of the control group who participated in traditional classes. However, there were no significant differences in motivation between the two groups.

Research Problem

This research verified how motivation impacts learning in an undergraduate Natural Sciences course, which covers scientific concepts from Biology, Physics and Chemistry.

Research Focus

It is expected on the premise that teacher training is a complex process, since it requires forming a group of people with different types of knowledge (Tardif, 2012), among them disciplinary knowledge (knowledge available to society, and integrated into the universities, in the form of disciplines). In this context, the motivation to learn Natural Sciences becomes a subject of extreme relevance, since it is directly related to academic achievement and quality training of future teachers. In addition, knowing what motivates and stimulates the students can potentially provide clues to designing and developing alternative teaching strategies that promote greater student participation and involvement in the classroom.

Research Aim and Research Questions

Based on the previous information, the following aims of this research were:

- evaluate the motivation of undergraduate students enrolled in a Natural Sciences course, at a public university in southern Brazil;
- determine if the motivation to learn increases throughout the course;
- identify the factors that motivate undergraduates to learn about Natural Sciences.

Research Methodology

General Background

The present research was developed in the context of a course in Natural Sciences at a Brazilian public university. This course is intended for the training of teachers in the area of Natural Sciences, enabling professionals to teach Science at the Elementary level and to teach Biology, Physics and Chemistry at the high school. More information about the course can be found in Lima and Pazinato (2020). In this context, this research has as its central theme studying the motivation of undergraduate students to learn about Natural Sciences in the year 2017. For this, was developed an exploratory research in which qualitative and quantitative methods were mixed.

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Sample

From 2012 to 2017, undergraduate students (n = 164) pursuing a degree in Natural Sciences, from a public university located in southern Brazil, were invited to participate in the research. The non-probabilistic sampling technique for convenience was used and classroom visits were conducted, with the goal of presenting and clarifying the objectives of the research, and to invite students to sign the Informed Consent Form.

Of the 164 students, 73 (56.5% of enrolled students) accepted to participate in the research, with 23 in 2017, 17 in 2016, 14 in 2015,10 in 2014, 8 in 2013 and 1 in 2012. Through the calculation technique for finite population, this sample corresponds to an error of 8.7% and has a 95% confidence level of the data.

Instrument and Procedures

Data were collected through the application of a questionnaire, based on the guidelines of Glynn et al. (2011). The questionnaire consisted of statements that were scored using the 5-point Likert scale: 1 = No Agreement and 5 = Total Agreement. The survey questions were organized into five motivational factor categories: intrinsic motivation, self-determination, career motivation, self-efficacy and motivation for grades. Additionally, the students evaluated the teaching strategies and activities employed during the course (Appendix I). For this, a scale ranging from 1 to 10 was used: 1 = Not Motivated and 10 = Very Motivated.

Cronbach's alpha values were calculated, to verify the internal consistency of the questionnaire. These values (range from 0 to 1) closer to 1 indicate a high relationship between the statements of the questionnaire, while values close to 0 indicate a low relationship. According to the literature, values ≥ .7 indicate that there was an accepted correlation between the different items in the questionnaire (Hair et. al., 2005). These data are presented in Table 1.

Table 1
Cronbach's alpha values for the investigated Motivational factors

Factor	Cronbach's Alpha
Intrinsic motivation	.917
Career motivation	.887
Self-determination	.861
Self-efficacy	.858
Motivation for grades	.803

Since all of the factors had Cronbach's alpha values that were greater than .8, it was possible to affirm that the instrument had good internal consistency.

Data Analysis

The data collected from the questionnaire was entered into a spreadsheet and the values for each of the categories were summed. This procedure resulted in a matrix with 73 rows (students) and 5 columns (categories of the questionnaire). Grouping of the students, according to similarity in the answers to the questionnaire, was accomplished using Hierarchical Cluster Analysis (HCA), with the aid of the Pirouette software.

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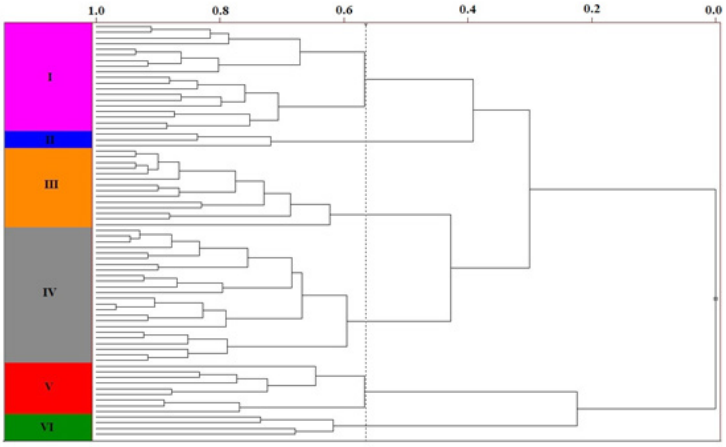
Research Results

The branches of the dendrogram (Figure 1) were generated from the HCA for a data matrix **X** (73×5). The HCA identified six groups of students (I-VI) with 56.5% similarity.

Figure 1
Dendrogram obtained from the Ward/Incremental method



Next, the data matrix was reorganized, based on the groups identified in Figure 1. This procedure allowed the data to be described according to the similarity of the responses in each category for each group (Table 2).

Table 2
Averages and standard deviations of the scores for each motivational factor category, according to the groups obtained with HCA. Maximum score for each category = 25 points

Category	**Group I** *n*=19 (26.0%)	**Group II** *n*=3 (4.2%)	**Group III** *n*=14 (19.1%)	**Group IV** *n*=24 (32.9%)	**Group V** *n*=9 (12.3%)	**Group VI** *n*=4 (5.5%)
Intrinsic motivation	20.7(2.2)	22.3(2.4)	21.4(2.6)	24.0(1.4)	20.3(3.5)	9.3(1.3)
Career motivation	17.6(2.4)	22.3(0.5)	17.1(2.3)	22.1(2.0)	14.1(2.4)	8.5(2.7)
Self-determination	16.5(2.2)	23.3(1.7)	22.5(1.5)	21.8(2.5)	13.8(2.6)	13.0(3.1)
Self-efficacy	16.1(2.0)	21.7(2.9)	17.4(2.1)	21.2(2.1)	15.9(2.9)	11.3(4.3)
Motivation for grades	13.8(2.3)	10.0(0.8)	19.4(1.8)	19.9(2.8)	21.0(2.7)	14.8(2.6)
	Moderate	High	High	Very High	Moderate	Low

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Group I corresponded to 26.0% of the total number of participants and is characterized by students who present a high degree of intrinsic motivation (20.7 ± 2.2) and moderate values in the other categories. Group V also presented heightened intrinsic motivation (20.3 ± 3.5) and motivation for grades (21.0 ± 2.7), but moderate values were observed in the other categories. Based on the analyses of these categories, these two groups (I and V) were classified as moderate, with regards to overall motivation.

Group II (4.2% of students) presented a low average value for the motivation for grades category (10 ± .8) but displayed high values in the other categories of the questionnaire. Group III (19.1% of students) presented high average values in three of the categories, with self-determination attaining the highest score (22.5 ± 1.5), followed by intrinsic motivation (21.4 ± 2.6) and motivation for grades (19.4 ± 1.8). In addition, this group also possessed moderate values for career motivation (17.1 ± 2.3) and self-efficacy (17.4 ± 2.1). Both of these groups were considered to have a high level of motivation.

Group IV corresponded to 32.9% of the students, thus representing the group with the largest number of participants. On average, these students presented high values in all of the categories analyzed, and was, therefore, considered to be a highly motivated group of students. In contrast, Group VI, with only 4 students (5.5%), presented low values in all of the categories. Despite the small sample size, it was concluded that these students were extremely unmotivated, throughout the course.

A combined comparison of the groups obtained with the HCA, indicated that a majority of the undergraduate Natural Science majors are motivated (56.2%). Furthermore, it should be pointed out that of the motivated students 32.9% are very highly motivated (Group IV) and 23.3% are highly motivated (Groups II and III). Of the remaining 43.8% of the participants, 38.3% were considered to be moderately motivated (Groups I and V) and 5.5% presented low motivation (Group VI).

In addition to this comparison, the motivation of the students was also assessed based on the year of matriculation (Table 3). For this analysis, it is important to note that the undergraduate degree in Natural Sciences lasts 4.5 years, thus the students from 2012, 2013 and 2014 were grouped. These correspond to students who are graduating.

Table 3

Number of students and percentages (%) according to the HCA-assigned group and year of matriculation

	Year of admission			
	2012-2014	2015	2016	2017
Group I (*n*=19)	5 (26.3)	6 (42.9)	4 (23.5)	4 (17.4)
Group II (*n*=3)	1 (5.3)	1 (7.1)	0 (.0)	1 (4.4)
Group III (*n*=14)	1 (5.3)	1 (7.1)	5 (29.4)	7 (30.4)
Group IV (*n*=24)	12 (63.1)	5 (35.8)	3 (17.7)	4 (17.4)
Group V (*n*=9)	0 (.0)	0 (.0)	5 (29.4)	4 (17.4)
Group VI (*n*=4)	0 (.0)	1 (7.1)	0 (.0)	3 (13.0)
Total	19 (100)	14 (100)	17 (100)	23 (100)

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When analyzing Table III, it was found that 63.1% (n = 12) of the most motivated students (i.e. those in Group IV) were students who are preparing to graduate (Year of admission 2012-2014). Thus, suggesting that the more senior students are more motivated than the students with fewer years of college experience.

Among the students that were admitted in 2015, most of them were clustered into Groups I and IV, with and 42.9% and 35.8% of the participants, respectively. Meaning that a majority of the students that enrolled in 2015 were moderately or very highly motivated. Students that enrolled in 2016 had a greater tendency to be clustered into Groups III and V (29.4% each), followed by Group IV (17.7%). Finally, the students that enrolled in 2017 had the highest percentage of students in Group III (30.4%), which corresponds to students who are highly motivated. However, it was also verified that 13% of the incoming students in 2017 were grouped into Group VI, which corresponds to students with low motivation. This data is very expressive, since three of the four students of this group are entering the course.

With regards to the factors that influence the motivation to learn during an undergraduate Natural Sciences course, the results obtained are summarized in Table 4.

Table 4

Frequency (in percentage) of the factors that influence the motivation to study Natural Sciences

Score/Scale	Frequency (%)						
	Course	Lecture classes (Theoretical)	Dialogue classes (Theoretical)	Laboratory classes	Internships	Academic Week	Projects
1	2.8	4.2	4.2	.0	5.5	8.3	.0
2	.0	4.2	4.2	1.4	1.4	2.8	1.4
3	4.2	1.3	.0	1.4	.0	1.4	.0
4	4.2	4.2	2.8	.0	.0	.0	.0
5	8.3	12.5	6.9	9.7	2.7	9.7	2.8
6	6.9	9.7	9.7	6.9	5.6	8.3	2.8
7	9.7	15.3	15.3	11.1	4.2	15.3	1.4
8	26.4	22.2	18.1	11.1	18.1	9.7	12.5
9	9.7	8.3	19.4	15.3	9.7	13.9	12.5
10	27.8	18.1	19.4	40.3	27.8	23.6	47.2
Does not apply	0	0	0	2.8	25	7	19.4

In the item about the motivation to take the undergraduate course, there is a high frequency of answers for level 8 (26.4%) and 10 (27.8%) of the scale used. In relation to the lectures (theoretical) it is possible to observe a high frequency for scores of levels 8 (22.2%) and 10 (18.1%). For the dialogue (theoretical) classes it is possible to observe a predominance for scores of 8-10 (≥18.1%). The students indicated that the laboratory classes were extremely motivating, with 40.3% of the students scoring this factor with a 10. The internships and academic week were also perceived as being motivational. For internships, 18.1% of the students scored this with an 8, and 27.8% gave it a score of 10. In the case of the academic week, 23.6% of the students scored this a 10. Of all the factors evaluated, projects were found to be the most motivating item according to students, with 47.2% of the participants giving it a score of 10.

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These results demonstrate that diverse opportunities are offered and provided to the students, and that students feel more motivated when they are given activities that use experiments and/or assign projects. In relation to the motivation to take the course, the arguments of three students are summarized below:

> *"I did not like the course at first, but I started to like it, and it's hard to imagine not being here now".*
> *"My dream of being a professor is my motivation for taking this class".*
> *"At the beginning of the course, my only concern was to earn my degree, but I fell in love with the course more and more after each class [...] with committed teachers and excellent professionals, it met all my expectations".*

Finally, the students were also asked if they intended to complete the undergraduate course. Based on the responses, it was found that 86.1% of the students intended on graduating Degree in Natural Sciences, and 13.9% did not intend on graduating. With regards to graduating, the arguments of two students are provided:

> *"I intend on graduating and having my degree, so that I can receive a salary increase".*
> *"I see in the course the possibility of change in Science Teaching so outdated by the traditional methodology".*

From these examples, it can be seen from the students who wish graduate, that both extrinsic (first example) and intrinsic (second example) factors play a role in this decision.

Discussion

In this research, it is presented the evidence about the levels of intrinsic motivation, career motivation, self-determination, self-efficacy and grade motivation in undergraduate students in a Natural Sciences course. Research on the factors that motivate students is paramount to understanding the needs of undergraduate courses, developing of effective teaching strategies as well as understanding the motives, emotions and feelings involved in the teaching and learning process. Additionally, in the case of teacher training courses, this type of research contributes to improve the training of teachers for Basic Education, which is lacking in Brazil (Boruchovitch, 2008; Cunha & Boruchovitch, 2012). While there may be several reasons for why future teachers engage in academic activities, but it is imperative that they are aware of the consequences, since they will become responsible for promoting and building, in their future students, the value of learning (Guimarães et al., 2002).

Through the data obtained, it was found that intrinsic motivation is a predominant characteristic of undergraduate Natural Sciences students. These students also displayed elevated, but less pronounced, levels for career motivation, grade motivation, self-determination, and self-efficacy. Clearly, each of these motivational aspects varied in each of the groups obtained by HCA, but in general it appears that students are motivated in the course. In the case of the results obtained for intrinsic motivation and motivation for career and/or grades (extrinsic) it is desirable that the course favors intrinsic motivation to the detriment of career motivation and / or grades. This evidence was identified in this study (Pozo & Crespo, 2009). Nevertheless, it is important to note that it is better for the student to be extrinsically compromised than being alienated or even giving up on the course (Pintrich et al., 1991). In this sense, the moderate and high average values in the career and/or grades motivation categories are possibly indicative of students that are committed to the course. Regarding the results for the self-efficacy category, it can be stated that the high average values obtained demonstrate that students make greater use of effective cognitive learning strategies, and are confident that they can achieve good learning

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outcomes (Chemers et al., 2001; Tuan et al., 2005). In addition, the self-determination results indicate that, for the most part, the students believe they have control over their science learning (Black & Deci, 2000).

Interestingly, when comparing the motivation of the HCA assigned groups, according to the year of admission, it was verified that more senior students were slightly more motivated than their younger counterparts, with less college experience. However, as previously suggested, the values for intrinsic motivation were high (>90%), meaning that these students display higher levels of interest and curiosity when learning Natural Sciences (Glynn et al., 2011).

Conclusions

Throughout the research, it was noticed that the motivation is a relevant aspect in the learning process. Particularly, the development of this study reflected on the importance of Motivation to learn Natural Sciences in the researched context, as this course will enable future teachers and academic achievement will be closely related to their teaching. It can be observed that the factors analyzed stimulate and provide subsidies for the involvement of academics in the course.

In general, the results indicate that most undergraduate students in question are motivated and that motivation rises throughout the course, since most of the less motivated academics are at the beginning of the course. The intrinsic motivational factors were predominant, which indicate that students are more interested in learning concepts than just getting good grades or some career advantage.

It is expected with this paper to contribute to the development of new research in this area. It is necessary to move towards detecting the fragile and consistent factors about motivation to learn scientific concepts, either of the course in question or others, so that the needs are pointed and worked, thus promoting the quality of the undergraduate courses. In this sense, it is important that research be developed to identify the activities that most motivate academics, because student involvement is closely related to good learning rates. In the case of the researched context, the undergraduate students highlighted the development of experiments and projects as more motivating activities, besides the participation in academic week and internships.

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Appendix I

Part I

As described in the literature by Glynn et al. (2011).

Part II

INSTRUCTIONS: This questionnaire contains statements to evaluate your motivation to take the undergraduate Natural Sciences course. Please score the following items using a scale ranging from 1 to 10: (1 = Not Motivated and 10 = Very Motivated).

1. Express how motivating it is to take the undergraduate course in Natural Sciences:
2. Express how motivating following course activities are:

a. Lectures (theoretical)
b. Dialogue classes (theoretical)
c. Laboratory classes
d. Internships
e. Academic week
f. Projects (Institutional Scholarship Initiative Program - PIBID, research scholarships, extensions, new talents):

3. Do you intend on completing your undergraduate program?

( ) Yes ( ) No

* For all of the items, space has been provided for justifying the answers.

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