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MOTIVATION, LEARNING AND EMOTIONS: ENGAGING STUDENTS WITH SCIENCE FLIPPED CLASSROOM

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Abstract

Motivation is an important construct in the teaching and learning process. A low-motivated student is uncommitted, with little engagement in the learning process, is not available to focus on learning tasks or processes and has low relatedness/belonging with the school environment. Motivation and resilience are two facilitators of science's teaching and learning process. In this context knowing teaching methodologies that promote school motivation is very important for physics and chemistry teachers. In a Portuguese upper secondary school class in the science field, an action research project was planned and implemented during a school year. The aim was to decrease apathy and disinterest in learning chemistry and physics, after confinement, improve study habits, and develop facilitators of the learning process. The intervention consisted of using active learning methodologies centred on students: an inverted classroom, accompanied by practical work with laboratory stations. These two methodologies allow a student-centred class and very diverse tasks to be performed during the teaching and learning process. So, throughout the research time, during the school year, the implementation of the intervention (the active methodology applied to it) was the focus of the research. This research, with the characteristics of quantitative research, followed the methodology of action research. The data were collected, through a questionnaire (already validated for the Portuguese population) at the beginning (after two months of intervention) and end of the school years (after the intervention). The questionnaire, containing statements, is structured as a self-response, with a Likert scale, ranging from totally true (5) to totally false (1). It is based on the achievement goal theory, self-regulation model, and instrumentally, and collects data regarding learning strategies applied by students. The results revealed that these methodologies allowed the students' motivation maintenance throughout the school year and that teachers as a relevant role in preserving the students' motivation.

Keywords: *Motivation, science field, active methodology, flipped classroom, laboratory stations.*

1. Introduction

The pandemic occurred in 2019, and the confinement during long periods left scratches on students, especially young people. The sense of belonging to a group became tenuous and school experiences began to occur via mobile phones or computers. The teacher and student interactions were mediated by mobile phones or computers (when students have them). The students' study habits and schoolwork organization were lost over time and, at the end of two years of confinement, students were poorly motivated to resume their studies. Gaps in learning and emotional levels had to be minimized and some schools proposed projects in this regard. This research project emerges in this context.

Motivation is fundamental to human agency and volitional behaviour and is determined by a complex interplay of internal and external factors. Motivation offers the reason/ trigger for individuals to behave in certain ways and to take action to achieve a goal or to fulfil a need or expectation. (Gopalan, Bakar, Zulkifli, Alwi, & Mat, 2017). All motivations have underlain three basic psychological needs: autonomy, relatedness (sense of belonging to a group) and competence.

Self-determination theory (SDT) is a macro-theory of motivation, emotion, and personality in social contexts (Deci & Ryan, 2000). SDT defines three categories of motivation: Amotivation (a complete lack of intent to do something), Extrinsic motivation (the behaviour is triggered because it will lead to an outcome which is separate from the self) and intrinsic motivation (the behaviour is carried out because it is inherently interesting or enjoyable. All motivation has underlain by three basic psychological needs (relatedness, autonomy and competence), the fulfilment of which affects one's level of motivation and psychological well-being. Six mini theories emerge from SDT, explain human behaviour in terms of psychological needs (Ryan & Deci, 2017).: cognitive evaluation theory (CET), organismic integration theory (OIT), causality orientations theory (COT), basic psychological needs theory (BPNT), goal contents theory (GCT), and relationships motivation theory (RMT).

1.1. Achievement Goal Theory

Motivation has been related to the achievement of goals. The construct of competence as being central to the Achievement Goal Theory (AGT). According to AGT, achievement goals are personal (internal goals), and characterized by being future-oriented and viewed as cognitive representations of future outcomes (Hulleman, Schrager, Bodmann & Harackiewicz, 2010). These internal goals depend on how personal competence is perceived and are context-dependent (Hulleman, Barron, Kosovich & Lazowski, 2016).

Mastery goals (or learning goals) are related to personal needs of increasing competence, whereas performance goals are related to demonstrating competence to others (Elliot, 1999). Both types of goals help students focus on approaching or moving toward success. Students having a learning goal were aiming to improve over time and develop skills. In contrast, students holding a performance goal we are pursuing outperform and demonstrate a skill to others.

Students who advocate prominent levels of performance-approach goals tend to attribute success to unmanageable factors (Seifert, 1995) such as innate abilities or intelligence rather than due to effort or persistence. They usually adopt shallow cognitive strategies as rehearsal (Ho & Hau, 2008), demonstrate a reluctance to seek help (Butler, 2006), experience increased negative achievement emotions (Huang, 2011), and have low perceptions of success (Daniels, Haynes, Stupnisky, Perry, Newall & Pekrun, 2008). Students who advocate mastery-approach goals usually hold a mindset that is based on believes that their ability to learn can be improved through work and persistence (Buluş, 2011; Grant & Dweck, 2003). (“Achievement Goal Theory Review: An Application to School Psychology”)

1.2. Organismic Integration Theory

Many times, individuals perform a task because they must do it (is a duty) without being involved with it. It means that it is not a requirement to have an intrinsic motivation to do a task, but extrinsic motivation is enough to engage in it. In this context emerge the organismic integration theory (OIT) of SDT, which addresses people's extrinsic motivation (EM) and perceived locus of causality (Ryan & Deci, 2017). Organismic Integration Theory is a sub-theory of SDT which presents four subtypes of extrinsic motivation, each with a different perceived locus of causality: external regulation; introjected regulation; identified regulation and Integrated regulation. (Ryan & Deci, 2017).

Extrinsic motivation is an external regulation with the lowest levels of autonomy. In this case, the behaviours conduct to satisfy external demands or to obtain external rewards and have an external perceived locus of causality. The second least autonomous form of external motivation implies introjected regulation behaviours conducted to avoid guilt or anxiety or to enhance self-esteem. Here we can find to some extent external perceived locus of causality. The identified regulation behaviours are carried out once a person has consciously identified the personal importance of doing the task (for instance, studying the content which, has relevance to one’s desired career, but that is not enjoyable), having a slightly internal perceived locus of causality. The most autonomous form of external motivation is integrated regulation, which implies behaviours that were assimilated into the self. These behaviours have been internalised through self-examination and are congruent with one’s needs and values. Persons with integrated regulation are engaged in willingly being self-determined but still performing for a separable outcome. In this case, the locus of causality is perceived as internal.

Has Ryan and Deci (2017) referred, fulfilling the needs of autonomy, competence, and relatedness helps to further internalise extrinsically mediated behaviours. So, a person can pass from a behaviour conducted as an obligation (external regulation) to an integrated regulation behaviour that emerges as a personal need. The greater the internalization, the more likely people are to persist in the task, perform efficiently, and enjoy doing it, which increases well-being (Ryan & Deci, 2017).

1.3. Active learning strategies: flipped classroom and laboratory station methodologies

In flipped classroom teacher use teaching strategies like visualization and technology. Students receive the information, by watching, reading, writing, to hearing through visual means (videos, text, images, flow charts, graphic organizers, concept maps and Venn diagrams) allows students to grasp information more effectively through visual memory, they are more able to retain both the previous learning and new information for a longer time. In a flipped classroom, students led classrooms, not only because they access contents when and where they want, but also because in the presential classroom, all activities are programmed to be students centred. To facilitate student-led instructions, teachers encourage students to see the materials made available by teachers before face-to-face classes. Students are encouraged to think critically regarding new content and, in the presential (face-to-face) classroom pose questions, to allow more effective feedback. Teachers encourage students to perform their studies at home and bring their learning outcomes to the classroom. Reading & writing technics are used during the teacher's visualization of the materials prose, as students must write their notes, read text or textbooks, and note-taking (Ribau, 2020 and 2022).

In the classroom, technology is used as a tool for active learning strategies. The use of simulations and modulation programs, and programmes for acquiring and analysing data are some of the applications of technologies. Technologies are also used to perform regular assessments, allow more allowed more captivating and interesting classes, and diversify the proposed activities in the classroom. This promoted a more inclusive and effective learning environment that improves inquisitiveness and collaboration among the students and allows teachers to collect data on student performance.

In the practical classes, laboratory stations are based on teamwork namely collaborative work and hands-on and minds-on activities. This methodology allows the implementation in classes of 4 or 5 different tasks, that explore the same theme/content using a different approach, for instance: one task uses the computer to do simulation/modulation, the other two tasks are practical work, and another is an exercise resolution based on real data. Studies reveal that group assignments improve teamwork and help students to succeed (Rita, Lopes, Esperto & Ribau, 2019). As in laboratory station models students handle, and manipulate materials and equipment (simple as rulers or more complex as sensors) and work in groups, allowing kinaesthetic Learning (or embodied cognition). The fact that students are moving through the islands/laboratory stations permits greater involvement of students in activities. The tasks are students centred and the teacher during the classes follows the progress of the accomplishment of activities, gives students support when passes through the groups and clarifies their doubts.

2. Methods

This research was designed as an exploratory and descriptive case study, with a methodology based on self-response questionnaires in a convenient experimental population of the 10th grade (26 students (15 and 16 years old) in the upper secondary school in the Lisbon metropolitan area. The research goal was to perceive the impact of, the flipped classroom with laboratory stations, on their motivation. The students that were the object of study are in the same class and were chosen randomly among other classes. The intervention (the methodology of the laboratory stations model and flipped classroom) was implemented between September 2021 and June 2022.

2.1. Research design

Regarding the intervention (flipped classroom with laboratory station), the data collection occurred in November, and June. During the school year (32 weeks), students performed seventeen experimental classes at laboratory stations. They also experienced the flipped classroom throughout the school year.

The teacher informed students that, the survey was anonymous, as the instrument was for research purposes only, and, that the main goal of the research was to understand the impact of the laboratory station classes and the flipped room on their motivation. The intervention process began in September 2021 and finish in June 2022.

The scholar motivation questionnaire (SMQ) validated for the Portuguese population (Cordeiro, 2010; Cordeiro, Figueira, da Silva & Matos, 2012) is a multidimensional questionnaire, consisting of 87 closed questions, that evaluates, from the student's point of view, their motivational processes, the objective structure promoted by the teacher in the classroom, the teacher's motivational style, the differential use of learning strategies, and their school performance. SMQ scales are quoted using a five-point Likert scale. Students respond to each item by opting for an alternative, on a 5-point scale. (1: If you think the phrase is totally false; 2: If you think the phrase is false; 3: If you think the phrase is truer than false; 4: If you think the phrase is true; 5: If you think the phrase is totally true). The students used the five response possibilities to evaluate the items. The quotation of the items corresponds to the numerical value suggested in each response.

3. Discussion

The research regarding Goal Achievement is reflected in two dimensions: “A. Perception of the orientation of the teacher's objectives” and “Guiding students' goals” (Table 1). In both dimensions, the learning (mastery)-oriented objectives and performance-oriented goals, were analyzed. The data presented allow us to conclude that the Orientation goals perceived as promoted by the teacher are related to the student guidance goals. The performance-oriented goals are related to external regulation and introjected regulation. The mastery goals can be related to identified and Integrated.

Table 1. Specific Comparison of average score between the two moments of collecting data.

Dimensions	Scale	November 2022 average scores	June 2023 average scores
Perception of the orientation of the teacher's goals	A1. Learning (Learning-oriented objectives)	3.91	3.94
	A2. Performance (Performance-Oriented Goals)	2.91	2.90
Guiding students' goals	D1. Learning (Learning-oriented objectives)	4.18	4.05
	D2. Performance (Performance-Oriented Goals)	3.73	2.43

Meta-analyses performed by Huang (2012) and Hulleman and collaborators show positive associations between performance-approach goals and academic achievement (Huang, 2012; Hulleman et al., 2010). But students that present performance-oriented goals, can simultaneously experience negative cognitions and emotions, which are not good for their well-being (Daniels, Haynes, Stupnisky, Perry, Newall & Pekrun, 2008). Learning goals are associated with accomplishing an activity and feeling continuously engaged in it (Senko & Harackiewicz, 2005), and experiencing enjoyment and fewer negative emotions (Huang, 2011). It should be acknowledged that the relationship between learning (mastery) goals and grades tend to be indirect (Mouratidis, Michou, Demircioğlu & Sayil, 2018).

As one aim of the intervention was to promote students' autonomy and self-regulation, it is possible to conclude that this goal was achieved for most of the students in this class. This can be assigned also in data presented in Table 2, which shows that students' perception regarding classroom climate (promoted by the teacher) implies a greater value of students' autonomy and rather control. And this perception has a slight increase during the school year.

Table 2. Specific Comparison of average score between the two moments of collecting data.

Dimensions	Scale	November 2022 average scores	une 2023 average scores
C. Perception of classroom climate	C1. Autonomy vs. Control (Teacher as the promoter of autonomy versus controller)	3.38	3.45

The learning strategies scale assesses the use of it by students according to a structure of twenty-nine items organized in five scales: the rehearsal strategies scale (F1); the elaboration strategies scale (F2); the organization strategies scale (F3); the critical thinking scale (F4); and the metacognitive strategies scale (F5), Table 3.

Table 3. Specific Comparison of average score between the two moments of collecting data.

Dimensions	Scale	November 2022 average scores	June 2023 average scores
F. Learning Strategies	F1. Rehearsal	3.67	3.56
	F2. Elaboration	3.78	3.76
	F3. Organization	3.75	3.82
	F4. Critical thinking	3.55	3.51
	F5. Metacognitive self-regulation	3.83	3.76
	Average	3.72	3.68

It is possible to see that there was a slight decrease in the use of learning strategies from the first to the second data moment collection. Being the rehearsal the learning strategies with a higher decrease. It also should be noted that "Organization" was the learning strategy that had a higher increase. This result can be related to the teacher promoting learning (mastery) goals and has been corroborated by other research work (Dawe, 2020). It is also important to emphasise aimed of increasing study habits, and the intervention used in this study allowed it.

It should be noted that researchers found that students with mastery-approach goals tend to use effective cognitive strategies as metacognition, that help them comprehend deeper insight into a subject/content and retain knowledge/skills (Huang, 2011). These students are better equipped to apply their learning to new situations as opposed to students who privilege memorization of a task that is quickly forgotten and are difficult to apply to new settings.

4. Conclusions

The main goal of this project was to develop students' autonomy, improve their study habits and simultaneously increase motivation to engage in school activities and develop learning process facilitators

in chemistry and physics. To achieve these goals, active strategies were used, and classroom environments were modulated to allow students centred classroom, and student-centred learning process. From the data collected, it is possible to perceive those strategies used, promote not only, autonomy, and learning goals, as it was possible to maintain good levels of motivation during the school year. Students enjoy the laboratory classes and the classroom activities.

This study's limitation is related to the small sample (26 students) and the implementation time (one school year).

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