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Review Article

Analysis of self-regulation in bioscience learning in university students

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Abstract

The brain plays a vital role in the development of the human being, in which the ability to self-regulate emotions is key to human adaptation, since there is a link with the neural bases of Self-Regulation. Aims: to relate General Self-Regulatory Capacity to Self-Regulation in Bioscience Learning and university students' marks. Method: The research was conducted with 66 university participants, aged between 20 to 27 years, who responded to the adapted Emotional Regulation (ERQ) and SRLAQ_KEY questionnaires, with added items from the State-Trait Anxiety Scale (STAI). Results: The data reveal that the most important significant differences ($p<0.05$) were in Self-Regulation Capacity for Bioscience Learning between individuals with a mark equal to or higher than 7, and those with marks under 7. Conclusions: The significant results between Self-Regulation and university academic performance are worthy of note, and we conclude that Bioscience Learning students show a better capacity for Self-Regulation.

Keywords: Emotion, Teaching-learning process, Science.

Introduction

The importance of the brain in all aspects of life is great. In this respect, Educational neuroscience is understood as the discipline that studies how the brain learns (Mora, 2013) and is considered the research discipline, approached in an interdisciplinary way, in the fields of Psychology, Neuroscience and Education. For Clouder et al. (2008), emotions do matter, because they are unconscious reactions that nature itself has provoked to guarantee our survival and that we must learn to control. Furthermore, the results of a study by these authors show that systematic Emotional Education programmes affect the overall development of a person since they reduce disciplinary problems and provide greater motivation for study, leading to better academic results, a more positive attitude and improved relationships. In this sense, the ability to control emotions, that is, to self-regulate them, is fundamental for human adaptation. An increasing number of studies seek the neural bases of self-regulation (Ochsner & Gross, 2005), and it has been found that the suppression of emotions causes more negative emotions than positive (Gross et al., 2003).

Lucia (2010) considers that, in recent years, the neurosciences have been uncovering the incredible mysteries of the brain and its functioning, providing pedagogy with essential knowledge about the neural bases of learning, memory and emotions. In this way, every educational agent must know and understand how the brain learns and processes information, since this is the basis for pedagogical innovation and the transformation of education systems. Thus, educational neuroscience helps bridge the gap between neuroscientific research and pedagogical practice.

A person can, therefore, change his/her behaviour from the knowledge acquired by experience, thus permitting him/her to adapt to new environmental and social situations. Likewise, memory is a phenomenon that is inferred from these changes, giving our lives a logical sense and continuity of things (Morgado, 2005). In this way, the complex process that takes place inside the body must be considered to change behaviour according to certain environmental conditions. Perceptive, cognitive and motor control processes mediate in the adaptation of the behaviour to the environment. In other words, the brain processes all the stimuli it receives from the environment. It compares the result of this procedure with the previous one and creates a motor response according to the stimuli it has received (Aguada - Aguilar, 2001).

Garza's study (2017) and Zumalabe (2014) reflects on how the principles of cognitive neuroscience have revolutionised concepts such as intelligence and development. So much so that brain plasticity must be considered the brain's ability to remain open to the continuous influences of the environment throughout life and to be modified by it. However, the neural mechanisms involved in learning, acquiring and consolidating memory are not yet fully known, and there is still much to unveil. Scientists, therefore, believe that the strengthening of these connections through the excitatory neurotransmitter glutamate is the mechanism responsible for the storage of some memories (Ortega & Cesar, 2010).

Emotions play a critical role in the information we perceive from the environment, influenced by individual and social experience (Bizquerra, 2000; Mellado et al., 2014). This is closely related to Self-Regulation, which is the capacity that an individual has to regulate himself/herself when faced with a situation or event, without the need for intervention from other external agents; in other words, the capacity of a person to adapt his/her behaviour according to the specific situations (Block & Block, 1980; Kopp, 1982; García, 2012). There is a correlation between the emotions that future teachers experience when they are students and those they experience when they work as trainees, although the negative ones tend to decrease (Brígido, Bermejo, Conde, & Mellado, 2010).

Considering emotions and the learning of Bioscience content, we can say that emotions towards natural and biological sciences, in particular, tend to be positive, while emotions towards sciences such as physics, chemistry and geology tend to be negative (Borrachero, Dávila, Brígido, Gómez del Amo, & Mellado, 2014). At the same time,

students' participation in the learning process must necessarily be active, which, again, bears a relation with how teachers generate or stimulate this participation (Revel & González, 2007).

In this respect, studies such as that of Brígido, Couso, Gutiérrez, & Mellado (2013) analyse the emotions of future primary school teachers in three Spanish universities. These authors worked on the teaching and learning of natural sciences. The results show an increase in positive emotions in the expectations of their future teaching of science-based content and a marked decrease in negative emotions in students of these subjects at the lower stages. Likewise, Olić, Ninković & Adamov (2016) verified the relevance of the existing psychometric properties in the learning of sciences linked to the motivation of the subject, reflecting the significance of the theoretical model used in the study.

Research into Self-Regulation in student learning is essential in today's world, given that it has an enormous impact on the implementation process and the success and effectiveness of training in general, which, in turn, is key to students' mastery of their future profession and in attaining professional skills (Hortigüela & Pérez-Pueyo, 2016; Keller & Kesberg, 2017; Khusainova & Ivuyina, 2016). Metacognition, therefore, determines the knowledge a person has of his/her own cognitive processes and products or any other matters related to these. Put differently, metacognition allows us to understand and self-regulate our own learning, and to plan the way in which we want to learn and value our actions in such a situation (Džinović, Đević, & Đerić, 2019; Zulma, 2006)

However, Zimmerman (1995) and Džinović et al. (2019) stated that Self-Regulation includes much more than metacognition, as it implies a certain sense of self-efficacy and personal assertiveness, as well as motivational and behavioural processes that can set this self-regulation system in motion.

We found other adaptations to the General Self-Regulation questionnaire, linked to both the educational and sports fields, as is the case with the research carried out by Oriol, Gomila, & Filella Guiu (2014). Some research, such as Olakanmi's (2016), developed a questionnaire that aimed to measure learning processes and co-regulation during science learning through collaborative learning.

The present study aims to analyse the capacity for General Self-Regulation and Bioscience Learning in university students and the relationship with their marks.

Methodology of Research

General background of research

This study is part of a research project aimed at exploring the influence of emotions on science learning at university level.

The research design is observational, descriptive and cross-sectional. Is a quantitative investigation carried out through the application of two validated questionnaires. The first one is from Gross (2003), whose purpose is to inform about the capacity for Self-Regulation an individual has in general terms, and the second one, from SRLAQ KEY (2004), focuses on items that allow us to analyse the students' level of anxiety concerning Bioscience Learning. Both instruments were adapted to the objectives of the research. We also used a third resource, a theoretical examination related to Bioscience contents. Sex was also considered as an independent variable and General Self-Regulation, Self-Regulation referring to Bioscience Learning and qualifications, as dependent variables.

Sample of research

To carry out the research process, we selected a convenience sample of 66 university students in the third year of the degree in Primary Education at the University of Extremadura (Badajoz). Participants were 20 men and 46 women between the ages of 20 and 27 (mostly 21).

Instrument and procedures

Several instruments were used to determine the capacity for emotional self-regulation in Bioscience Learning of university students enrolled in the degree of Primary Education. The first of these is an adaptation of the Gross & John (2003) questionnaire, which informs on the individual's ability to self-regulate in general terms. It was translated and framed according to our requirements. The questionnaire consists of 6 items that should be valued from 1 to 4 on a Likert-type scale. Items 1, 4, and 6 are related to the extent to which people try to change at a cognitive level the emotional impact that determines certain situations. Items 2, 3, and 5 are linked to the extent to which the person chooses to inhibit their expressive behavior. The second questionnaire is an adaptation of the SRLAQ KEY from Khusainova & Ivutina (2016), which is composed of 67 items from which we selected 16. Those were then reformulated to refer to bioscientific learning. In addition, 4 final items extracted from the State-Trait Anxiety Inventory (STAI) were added, and those indicated a relatively stable propensity to anxiety, which characterized individuals with a tendency to perceive situations as threatening. This allowed us to analyze the level of anxiety of students in the context of Bioscientific Learning.

Experts from the Department of Psychology of the University of Extremadura validated both questionnaires using the computer programme INFLESZ v.1.0, which gave us an idea of how easy the items that make up the questionnaire were to read.

Our third instrument was a theoretical examination of Bioscience contents, on living beings and the environment, consisting of 11 short answer questions. This exam was validated by university professors who are experts in science teaching, in order to ensure that the objectives of the subject were met. In order to do so, they were provided with a copy of the exam and they had to fill in a table indicating the relevance and clarity of each question on a scale of 1 to 10. They were also allowed to offer any comments or suggestions on the proposed questions.

All study subjects were asked to consent to the use of their research questionnaires and were informed of the purpose of the study. Students were asked complete the two Self-Regulation questionnaires before taking a Bioscience content exam. We were aware of the importance of guaranteeing the anonymity of the participants as well as the correct completion of all scales. There was no time limit to complete them.

Participants first completed the General Self-Regulation questionnaire. Items 1, 4 and 6 had to be considered independently of items 2, 3 and 5 to analyse the questionnaire since the former refer to cognitive re-evaluation (RE), while items 2, 3 and 5 identify emotional suppression (ES). The subjects then completed the Self-Regulation questionnaire regarding Bioscience Learning. This questionnaire consists of 20 items, of which 16 are related to the capacity for Self-Regulation that the individual has when faced with scientific tasks, and the 4 final items relate to level of anxiety, i.e. two questions on anxiety-state and two questions on anxiety-trait.

Both the first and second instruments have a Likert-type scale, in which the participants had to score each of the items from 1 to 4, where 1 is strongly disagree, 2 disagree, 3 agree and 4- completely agree.

After completing both questionnaires, the students took the exam on the university Bio-scientific contents previously taught in the classroom. We chose this moment because we assumed that this situation would provoke an elevated level of anxiety and influence emotional regulation considerably. The marks obtained by each subject allowed us to draw conclusions since they were compared with the results that we observed from the questionnaires.

Data analysis

The data obtained and coded were previously collected in a Microsoft Excel 2010® database for subsequent statistical analysis. Once the data had been obtained by the procedure and the instruments mentioned above, we analysed them descriptively and inferentially, using the statistical software SPSS version 22®.

Descriptive statistics

Average ( ), percentages (%) and standard deviations (DT) were calculated for the descriptive statistics.

Inferential statistics

Contrasts were made according to the principles to be complied with to decide whether the tests to be applied should be parametric or non-parametric in the inferential analysis: for the Principle of Normality, the Kolmogorov-Smirnov (K-S) test; for the Principle of Randomness, the Run test; and for the Principle of Homoscedasticity, the Levene test.

As for the choice of the test, given the normality of the selected sample, as verified by the K-S Test, the most suitable test for inferential statistical analysis was the "Student t-test", which is applied when a given characteristic is to be compared in a population, using a single sample but in two different circumstances, i.e. in pairs; and with a confidence level of 95% ($p<0.05$).

Results of Research

The results of the General Self-Regulation questionnaire, quantified between a value of 1 to 4, yielded an Average of 2.67 and a Standard Deviation of ± 0.39 for both sexes. The females yielded 2.70 ± 0.42 whereas the males 2.61 ± 0.31. Capacity for Self-Regulation in the female sex was greater than in the male sex, and this difference between the two sexes was statistically significant ($p<0.05$).

We analysed each item according to sex, with the following results (*Table 1*):

With regards to significance of Self-Regulation data regarding Bioscience Learning, we obtained the value of **(p< 0.05)** through the Student *t*, where all the participants were included.

The results that showed the assessment of the different items according to sex, in terms of the Self-Regulation in Bioscience Learning, were as follows (*Table 2*):

For both sexes together, the average was 2.69 ± 0.79.

It is noteworthy that the statement to which the students gave the highest value was number 3 "I usually complete all my work before the deadline", with an average of 3.07. However, students rated statement number 4 "I find it easy to differentiate between what is important and what is not important" higher, with an average of 3.15. The statement that shows the greatest degree of disagreement, both on the part of male students and female students, was 2.15 and 2.11, respectively, and item number 1 "Nothing distracts me when I prepare for my science exams (no friends, no movies, no matter what happens)".

To conclude, the and significant results achieved in the relationship between Self-Regulation and academic performance were framed, on the one hand, by marks higher and lower than 5 and, on the other, by marks higher and lower than 7, both according to their capacity for General Self-Regulation and in relation to Bioscience Learning (*Table 3*).

Table 1. Average ± DT of each item, in relation to each sex (female and male) and as a whole

	ITEMS					
	1	2	3	4	5	6
$\bar{x}$ Females	**3.11**	**2.37**	2.60	2.63	2.66	2.80
DT Females	0.80	1.04	0.91	0.93	0.83	0.72
$\bar{x}$ Males	**3.00**	2.30	2.30	2.85	**2.26**	2.95
DT Males	0.79	0.86	0.80	0.88	0.99	0.69
$\bar{x}$ Both together	3.08	2.35	2.51	2.70	2.54	2.85
DT Both together	0.79	0.98	0.89	0.91	0.89	0.71

The most significant values are indicated in bold

Table 2. Average ± DT of each item, in relation to each sex (female and male)

Items	$\bar{x}$ Females	DT Females	$\bar{x}$ Males	DT Males
1	**2.11**	0.80	**2.15**	0.88
2	2.57	0.66	2.65	0.59
3	**3.07**	0.80	2.80	0.95
4	2.69	0.67	**3.15**	0.59
5	2.93	0.61	2.75	0.72
6	2.68	0.67	2.65	0.59
7	3.00	0.80	2.80	0.89
8	2.85	0.63	2.80	0.95
9	2.58	0.72	2.75	0.79
10	2.37	0.80	2.50	0.89
11	2.20	0.69	2.50	0.76
12	2.80	0.83	2.60	0.94
13	2.54	0.72	2.75	1.02
14	2.63	0.90	2.80	0.83
15	2.68	0.71	2.74	0.99
16	2.74	0.85	2.35	1.09
17	2.78	0.87	3.00	0.73
18	2.24	0.77	2.75	0.79
19	2.67	0.70	2.95	0.89
20	2.40	0.84	2.90	0.79
$\bar{x}$ ± DT	2.63	0.25	2.75	0.22

The most significant values are indicated in bold

Table 3. Average ± DT of the General Self-Regulation and Bioscience Self-Regulation

Mark	General Self-regulation			Self-regulation in Bioscience Learning		
	$\bar{x}$	DT	Sig.	$\bar{x}$	DT	Sig.
<5	2.75	0.45	0.203	2.74	0.41	0.129
≥ 5	2.62	0.35	0.243	2.61	0.27	0.184
<7	2.81	0.40	0.167	2.89	0.44	**0.005***
≥ 7	2.64	0.38	0.192	2.60	0.28	**0.047***

*Statistically significant for a value of $p<0.05$, (n = 66).

The data reveal that the most important significant differences ($p<0.05$) were in the Self-Regulation Capacity for Bioscience Learning between individuals with a mark equal to or higher than 7 and those with marks under 7. In this sense, it becomes evident that the values derived from the Capacity for Self-Regulation, relate to a specific learning environment, and generate more relevant data valuable compared to General Self-Regulation with regards to certain marks.

Discussion

As deduced from the results obtained from the General AR questionnaire, adapted from the one proposed by Gross & John (2003), students from both the female and male sectors used Cognitive Re-evaluation more than Emotional Expression as a self-regulating mechanism in their daily lives. We found results obtained from this same questionnaire, adapted in this case to sports activity in Oriol et al. (2014), in which players used Cognitive Re-evaluation more than Emotional Suppression in the face of adverse outcomes. Specifically, CR (Self-Regulation) is the most commonly used strategy followed by emotional contagion towards peers (heteroregulation).

Re-evaluation implies a mental change that brings about a lower emotional impact in this particular situation (Gross & John, 2003). The use of this strategy based on Educational neuroscience through regulation has been associated with a decrease in physiological reactivity and with a greater exchange of emotions and greater social support (Richards & Gross, 2000). Positive emotional contagion to peers, according to Larsen & Prizmic (2008) is a strategy related to social support. Sharing emotions with others and dealing with them constructively increases well-being and promotes the perception of greater happiness. It follows that cooperative learning is a dynamic and useful tool for achieving more meaningful learning, where learning is by teaching, thus seeking to build new knowledge and skills through decision-making, social interaction and teamwork (Cruz & Béjar, 2014).

As for the relationship between RA capacity and learning, we have found few references, and even fewer that associate it with Bioscience Learning. In this respect, we can take Cristiana (2015) as a reference, since she considers that to value the RA, we must consider three fundamental aspects: metacognitive, affective and social. Moreover, she uses three instruments to study them, such as interviews (metacognitive, affective and social aspects), videos of the classes (affective and social aspects) and a questionnaire (metacognitive and affective aspects). She concludes that students with the best academic results also show a high capacity for RA. In this sense and in agreement with what has been said before, the emotional traits of the individual are of vital importance to maintain a good mental well-being and a sound cognitive health, since in this way the person will show the significant gains related to being in a correct state before a certain situation (Andrei & Petrides, 2013).

It is also necessary to mention Marić & Sakač (2018), who obtained relevant data on the metacognitive components related to cognitive regulation in preschool students. They proposed different problem-solving tasks where they concluded that the metacognitive skills of the participants were highly developed, and they also reflected that the self-regulation of cognitive strategies was significant and efficient in solving problematic tasks.

The role of metacognitive self-regulation, academic self-efficacy, and regulatory motivational styles not only predict, but also have a direct effect on academic performance. That is why these aspects have a direct impact on the students' own learning, demonstrating that the effect of self-control on achievement is influenced by self-efficacy. In other words, those students who increase their self-control when faced with a situation and believe in their own abilities to manage their emotions, show greater academic and personal success, regardless of the complexity of the learning process and whether they are autonomously motivated towards the task or not (Džinović et al. 2019).

Sadi & Uyar (2013) researched the relationship between self-efficacy and self-regulated learning strategies through a pathway model. Their results show that students have high self-efficacy and organisational strategies for completing a task when faced with difficulties, that may succeed in biology. Also, Kaya, & Kablan (2013) evaluated the relationship between learning strategies and the achievement of science at the Primary Education level, where they consider that the use of self-regulated learning strategies tends to have an impact on student learning and performance, and obtained significant results in seven of the nine learning strategies researched, associated with performance in science.

Khusainova & Ivutina (2016) present interesting results since they used the same questionnaire that we adapted in our study, albeit without modifications. They carried out the experiment on a sample of university students from the Humanities University of Moscow, Russia.

On the other hand, we found some interesting papers relating to anxiety states of university students. According to the results Pérez (2014) obtained after the completion of the STAI questionnaire, women present higher levels of both State Anxiety and Trait Anxiety. The study was also carried out on a group of university students.

Franco et al. (2012), reached similar results, obtaining data indicative of higher levels of both State Anxiety and Trait Anxiety in women than in men. However, studies by Cazalla-Luna & Molero (2014), indicate that Trait Anxiety is higher in women, but State Anxiety is greater in men, although the differences are not significant.

What is clear, despite the gaps that still remain, is that both emotions and RA and learning have a common neurophysiological origin, and that studies must consider the close relationship between these, thus reiterating our multidisciplinary commitment, from the areas of Psychology and Learning of Experimental Sciences, to fuse the affective and cognitive spheres in order to improve the learning process.

We may therefore conclude that students consider themselves capable of modifying their thoughts about a situation or event in such a way as to experience more positive emotions than negative ones, which constitutes a mechanism of self-regulation. Students with better marks also have high values of General Self-Regulation and Self-Regulation in Bioscience Learning, with statistically significant differences obtained in the latter. Thus there is a need to foster cooperative learning, in which learning is aimed at "learning by teaching"; students contribute all they know to their peers, improving in this way even the capacity for Self-Regulation of those who have not developed it sufficiently.

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