The use of the Socrative application to enhance student attention: electroencephalography data of attention levels

Marcelo Vettori
Pontifical Catholic University of Rio Grande do Sul (PUC-RS), Porto Alegre – RS, BRAZIL
ORCID: https://orcid.org/0000-0003-0490-6320
Email: mvettori@gmail.com

Andreia Solange Bos
Federal Institute of Education Science and Technology of Rio Grande do Sul (IFRS), BRAZIL.
ORCID: https://orcid.org/0000-0001-6485-0002
Email: andreia.bos@gmail.com

Lucília Gomes Donato
Pontifical Catholic University of Rio Grande do Sul (PUC-RS), Porto Alegre – RS, BRAZIL
ORCID: https://orcid.org/0000-0001-8504-1263
Email: luciliagomes84@gmail.com

Milton Antônio Zaro
University of Rio Grande do Sul, Dep. CINTED, (UFRGS)- Porto Alegre - RS, BRAZIL
ORCID: https://orcid.org/0000-0002-0459-8981
Email: zaro@ufrgs.br

Abstract

The use of the Socrative App (instant response feedback app) was investigated as a tool to enhance attention in the development of Meaningful Learning for Engineering students in a Physics discipline. The subjects, students of Engineering, are evaluated in their learning by using a printed list of exercises comparatively when they perform a single exercise in the Socrative App. This study presents favorable results to the use of this application, since it encourages engagement in the classroom, motivated by the use of this technology, as well as increased attention in the absence of distracting elements in a list with several exercise options.

Keywords: Attention. Meaningful Learning. Socrative App.

1. Introduction

Applications ranging from experience simulators to information managers, through instant messengers and social networks, join immediate feedback applications to enhance the teacher's teaching and, consequently,

the students' learning. A new meaning is given to the classroom, as the teacher starts to follow the results of the questions answered by all students present or not. Depending on their answers, different paths can be taken in the teaching processes developed by the teacher.

Mobile devices, in this context, move from communication and entertainment electronics to auxiliary teaching tools. Related studies confirm these arguments. Alencar et al. (2015) used the WhatsApp application as a teaching support tool in which students worked on their argumentation through writing. Honorato et al (2015) worked with a virtual simulator for the development of concepts about vectors in the teaching of Physics. The results of these researches demonstrate the importance of innovating and reinventing the classroom with appropriate methods in the use of these technologies. According to Valente (1999), methodological innovations require changes in the teaching and learning processes, which are much more profound, specifically in relation to the classroom, as this will have to be rethought in its structure, as well as in the pedagogical approach. This all goes hand in hand to modernize the teacher's teaching and stimulate meaningful learning for his students. According to Vettori and Zaro (2016), applications of this nature favor the engagement and also the attention of students, as they reflect on the paths that were taken to achieve and reach an answer. This also allows the resumption of questions, the raising of doubts and the dialogue with the teacher, since the teacher has on his computer (or mobile device) the answers in real time using the same application in the teacher's version.

Attention, in this sense, is a fundamental condition for the construction of meaningful learning that is discussed by the theories of Ausubel (1983) regarding the elaboration and the use of potentially significant materials. Studies in Neuroscience and Neuroeducation, according to Zaro et al (2010), state that students' attention is more intense when technological resources are used in the classroom, as the brain reacts to different external stimuli and, in this case, such stimuli are related by internal stimuli as the intrinsic motivation of each individual. Vettori and Zaro (2016), highlight that this motivation includes the fact that technology is “part of the mind and even the body” according to one of the research subjects.

The objective of this work is to understand how attention is favored with the use of the Socrative App in the classroom, its implications and the development of meaningful learning. We verified the effectiveness of this application, using an electroencephalogram (EEG) device known as Neurosky , validated as acceptable for this type of research according to the works of Velloso (2014) and Schuh (2016). In his doctoral thesis, for example, Velloso (2014) investigates how the subjects' attention levels increase with the use of learning objects to learn content. On the other hand, Schuh (2016) shows how it is possible to use Neurosky for the mobility of electric wheelchairs. In this study, the different levels of attention of students were compared when using the Socrative App with and without its presence. We measure students' attention levels in two situations. In the first, students resolved five questions on a printed list. In the second, a single question in the Socrative App.

2. Theoretical Fondation

2.1 Meaningful Learning

According to Ausubel (1983), learning is significant when it makes some sense to the learner (a term used

by Ausubel). In the process of learning information, you must interact and anchor on relevant concepts that exist in the cognitive structure of the learner. Therefore, the apprentice's learning process must rely on the use of previous organizers (PO) to anchor new learning. OPs are elements that must be previously presented in relation to new content, serving as a bridge between what the student knows and what he needs to know for meaningful learning to occur. This, in turn, will lead the student to the development of subunits, which will enable the construction of future learning. According to Moreira (1999), subunits are specific knowledge existing in the knowledge structure of the individual, which allows giving meaning to a new knowledge that is presented or discovered by him. For Ausubel (1983), there are two basic conditions for meaningful learning to occur. The first, the didactic material that must be potentially significant. The second, the apprentice's willingness to learn.

Potentially significant material is not in a book or class, but in the person, who is already predisposed to learn. For Moreira (1999), it is not exactly about motivation, or liking the material. For some reason, the learner must be willing to interact the new knowledge interactively with his previous cognitive structure, modifying it, enriching it, elaborating it and giving meanings to that knowledge. Consequently, the material prepared by the teacher will be potentially significant, as it will enable the learner to relate the contents to their cognitive structure in a non-arbitrary and non-literal way.

The basic idea of David Ausubel's (1983) theory of Meaningful Learning is that if it were possible to isolate a single factor as the most important for cognitive learning, it would be what the learner already knows, that is, the knowledge already existing in its cognitive structure with clarity, stability and differentiation; consequently, teaching should take such knowledge into account and, for that, it would be necessary to ascertain it in advance. The key concept of the theory is the concept of meaningful learning itself. Naturally, meaningful learning is meaningful learning; however, Ausubel's original proposal goes far beyond this tautology (MOREIRA, 1999).

Therefore, meaningful learning presupposes the reconstruction of existing concepts into new improved concepts. For this to happen, it is necessary to verify these previous concepts that the apprentice brings with him.

Ausubel (1983) presents as a basic idea that the teacher knows what the learner already knows so that, starting from the existing cognitive structure, to reach new and more elaborate knowledge than the previous concepts. In this sense, it is necessary to verify such knowledge in advance and, thus, verify the new knowledge. When the student is able to differentiate between previous knowledge and new knowledge when he finds stability and differentiation between new meanings, we can say that there was significant learning. Moreira (2009) highlights that in the interaction that characterizes meaningful learning, new knowledge must relate in a non-arbitrary and substantive manner (not literally) with what the student already knows.

In this sense, the cognitive structure is a set of subunits and their interrelations. For meaningful learning to occur, it is necessary that relevant subsunitors are available and that the student has the ability to relate new knowledge to previous knowledge. According to Moreira (2009), even if he has adequate knowledge, it will not help if the student does not know how to relate this knowledge to solve a problem.

2.2 Attention

Attention has a diversity of coming concepts. For each area of knowledge that studies it, attention has a view from researchers about what it is and what its function is in the human mind.

In the work "The neuropsychology of attention", Cohen, Sparling -Cohen and O'Donnell (1993) highlight that the word attention is an integral part of people's regular and everyday vocabulary. Thus, attention should be understood as a collection of cognitive processes that produce recognizable results and not as a single process. According to Velloso (2014, p.45), attention has a diversity of coming concepts. For each area of knowledge that studies it, attention has a view from researchers about what it is and what its function is in the human mind.

In the work "The neuropsychology of attention", Cohen, Sparling -Cohen and O'Donnell (1993) highlight that the word attention is an integral part of people's regular and everyday vocabulary. Thus, attention should be understood as a collection of cognitive processes that produce recognizable results and not as a single process. According to Velloso (2014, p.45), The cognitive sciences study attention as a set of mental processes, whether conscious or not. In turn, neuroscience understands attention as a certain physiological brain state.

Attention, therefore, has a fundamental role in the acquisition and construction of knowledge, since the processes involved in this part of the subject focus on what they want to learn.

Corbetta (1998) stresses that it is the role of attention to select the source of relevant sensory stimuli at the expense of others. In this model, attention can be seen as a process that acts on information from one or more senses.

Ladewig (2000) points out that, in the learning process, attention subsequently passes through three distinct stages: cognitive, associative and autonomous. In the first stage, the cognitive, the subject tries to understand the concepts. At this stage, there is a great burden on the mechanisms of care. In the associative stage, the subject develops knowledge; in this stage, the attention needs are minimized in relation to the previous one. Finally, in the autonomous stage, the related skill is developed, and the attention requirements are minimal, allowing the subject to redirect his attention to other focuses.

According to Velloso (2014), the analysis of the relationship between learning and attention makes clear the fundamental role of the latter in the development of the former and also indicates a cyclical and feedback process, in which attention generates learning to enhance the development of knowledge involved in the process or to build new knowledge, indicating a bidirectional cause and effect relationship.

Zaro et al (2010) highlight the work developed in the doctoral thesis of Tokuhama- Esppinosa in which the author discusses brain functioning and, in particular, the importance of attention and its role in the learning process. Tokuhama- Espinosa (2008) states that learning involves both focused attention and peripheral perception and that the human brain is designed more for oscillations than for constant attention. The relationship between attention and learning is significantly close. Tokuhama -Espinosa (2011), highlights that "if you don't pay attention you don't have a memory. If there is no memory, there is no learning. If we do not keep students with a good level of attention, there will be no learning".

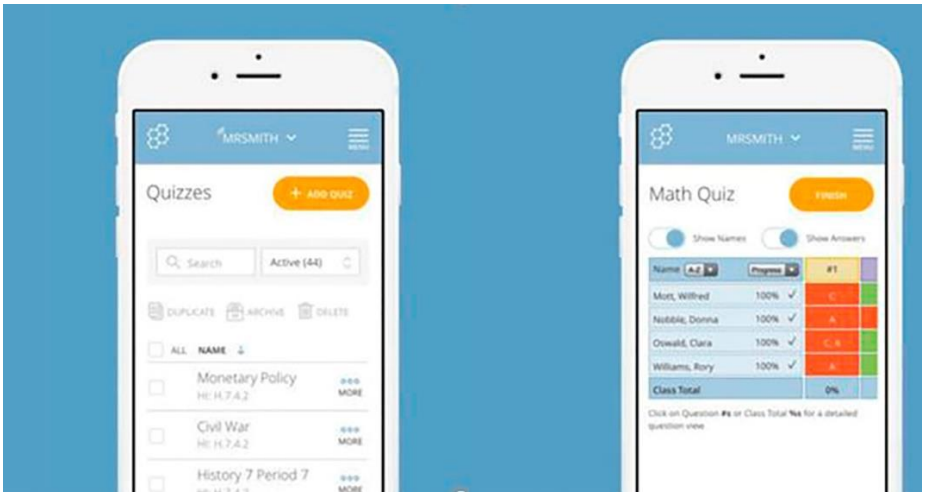
2.3 Socrative Aplication

The Socrative is a classroom application that provides effective engagement of students, allowing the

teacher to follow in real time the development and learning of a class. It is possible, from this application, to quickly evaluate students with previously planned activities or with quick questions to obtain an immediate view on the understanding of the subjects being worked with a class. From the results that appear immediately on the teacher's mobile device (or personal computer), it is possible to think and direct new paths for student learning.

Socrative can be used as a data collection tool to organize content according to students' prior knowledge in order to achieve, when possible, meaningful learning. It is a facilitating way for the teacher to think about how to develop these learnings, to plan, through the answers, and to investigate possible paths to be taken, identifying, based on the answers, the existence of conceptual errors, problems of interpretation and basic mathematics, which are necessary for the development of new knowledge. Figure 1 shows the illustrative image of the application and its functionalities.

Figure 1. Socrative application



Source - Adapted from Socrative App by the authors, (2020).

The Socrative is therefore a tool that assists the teacher in the task of getting instant feedback of the answers provided by students previously selected issues for some classroom activities. Students solve the questions in their notebooks, for example, and choose the answers (or provide them) through their devices and, in real time, the teacher observes the chosen or elaborated answers on his own mobile device (or computer). The teacher decides which directions to take to improve the dynamics of the classroom and consequently the learning of his students. This dynamic runs through a working method that can favor and expand the learning that is being built in the classroom with the use and facilities created by Socrative.

3. Methodology

The research is experimental, exploratory and has a qualitative and quantitative approach. The research subjects were six volunteer students from different engineering courses at a private university in the city of Porto Alegre, capital of the Brazilian state called Rio Grande do Sul. There were four female students and two male students. These students took a course in General Physics (Mechanics) and are aged between 19 and 21 years. The research subjects authorized the publication of their data and had their names preserved

in anonymity. They were named by the word "student" followed by a letter and a number (Student A1, for example).

In order to measure the attention levels of the research subjects, three Neurosky EEG headset devices were purchased. The devices have Bluetooth technology, which allowed, through a specific application, to obtain data regarding the levels of attention of the subjects during the performance of Physics exercises. Most measures were obtained with the Android smartphone due to the stability of the Bluetooth signal, something that was not possible with an Apple smartphone (iPhone 7). To obtain these measures, we looked for the Effective Learner application that can be used with the headset available in the virtual stores of Apple (iOS) and Google (Android).

The collection of data on the individual attention of each student was carried out in two stages based on:

(1) Resolution of a Physics problem in a printed list with four exercises of the same content (without the obligation to respect the presented order);

(2) Resolution of a Physics problem using the Socrative App, different from those presented in the previous item, however, with the same content.

After collecting these attention data, the teacher provided feedback on each resolution made by the students. The measurements were carried out in the classroom during four meetings.

Finally, a free interview was carried out, followed by the application of a structured questionnaire with each subject. We sought to know the impressions of the two stages of data collection, respecting two central themes: distracting elements and difficulties encountered.

We emphasize that steps (1) and (2) were repeated three times with each student. For each stage, the first time was aimed at resolving questions of type V (true) or F (false) that did not last more than three minutes for each student. The second time, presented multiple choice questions and took between three and five minutes for each subject. The third and last time, lasting more than five minutes, involved questions with calculations. These calculation questions were resolved on paper and the result found was later entered into the Socrative App.

The data obtained representing the attention levels were collected by the EEG Neurosky device (hardware) and decoded by the Effective Learner application (software). This application takes ten measurements every minute, that is, one measurement every six seconds. Each measure averages between the predominant levels of care, from the lowest to the highest.

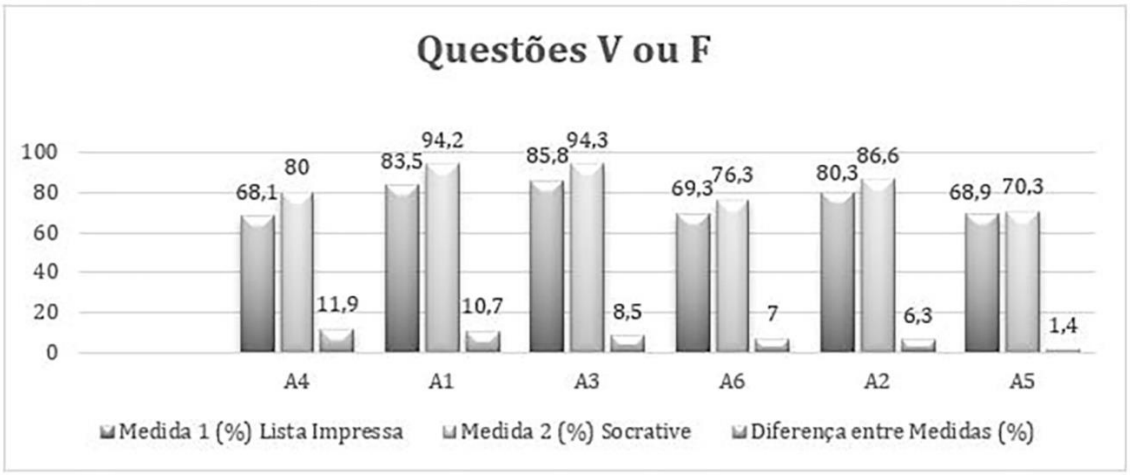
The measurements were performed in the classroom while the students resolved the questions proposed in steps (1) and (2). From the data collected, through the software, and the interview conducted together with the structured questionnaire, we sought to verify evidence of significant learning. Such evidence was interpreted from the crossing between the different (oscillations) levels of attention with the impressions of the research subjects.

4. Results and discussions

We present the quantitative results of the measures of the levels of attention reached by each student. The last column of each graph represents the percentage difference between measures 2 and 1. It is possible to notice that all of these values are positive, that is, there was an increase in attention in all measurements

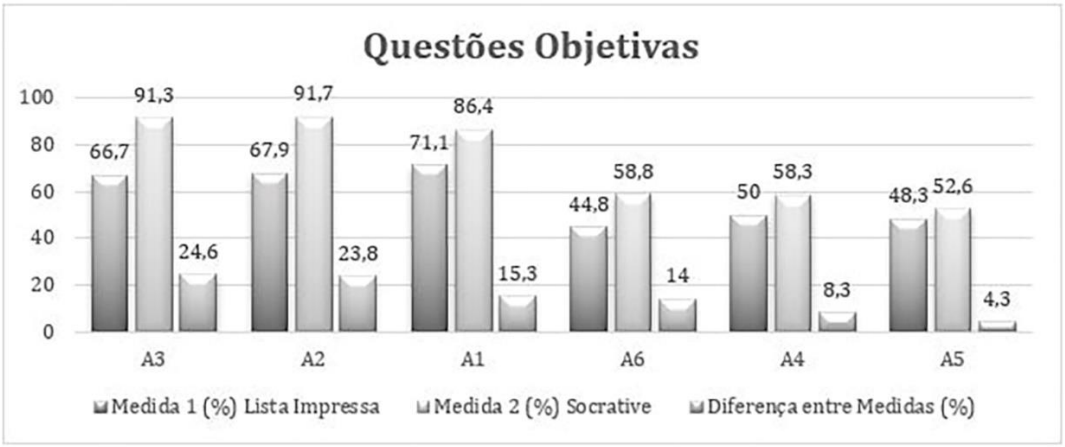
performed.

Graph 1 - First group of measures: questions of V (true) or F (false)



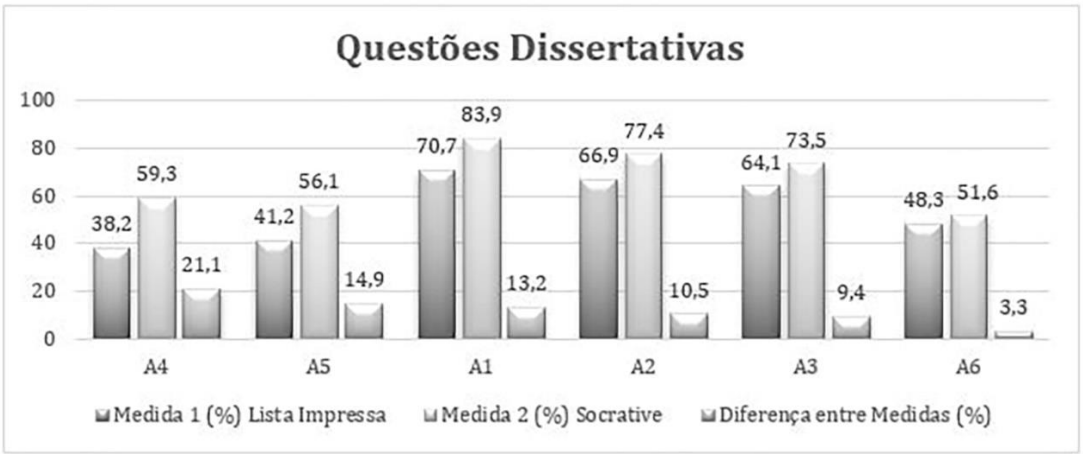
Source: Authors, (2020).

Graph 2 - Second group of measures: objective questions



Source: Authors, (2020).

Graph 3 - Third group of measures: essay questions



Source: Authors, (2020).

Table 1 shows the percentage differences (minor and major) per student between the first measure (printed list) and the second measure (Socrative) for each group of measures.

Measuring Group	Smallest% difference per student	Biggest difference% per student
1 the	1.4 (A5)	11.9 (A4)
2 the	4.3 (A5)	24.6 (A3)
3 the	3.3 (A6)	21.1 (A4)

Source: Authors, (2020).

In almost all measures, the relationship between the levels of attention and the perceptions of students during the resolution of questions was evident. In the two specific situations mentioned above, attention levels are lower when students solve a printed list with four exercises. All students state that they sought the easiest question when they received the printed list to solve the four exercises available in each. This curiosity about the easiest question affects the final results of the attention levels. Due to this search for the easiest question, the resumption of readings between questions leads the subject to a movement that involves, at first, mechanical learning. There is, by the subject, a search for previous knowledge that can be differentiated and integrated to the new challenges, that is, an attempt to find something similar to what has already been worked on previously, something that is familiar. Not finding, the subject chooses the question that seems most convenient to solve. Therefore, the number of questions available in a list is one of the possible distracting elements for a student. Thinking about personal problems or something that is not related to the issue, significantly changes the levels of attention, too, according to the reports. However, when students face some difficulties related to the knowledge to be tested, attention levels again fall

However, the drop in attention levels is also associated with the subjects' difficulties in differentiating and integrating new knowledge to those existing in their cognitive structures. Student A6 had the biggest percentage difference in the second group of measures, because according to his report “there was distraction with the proportional relations” that made him feel challenged and motivated to solve the questions in the printed list. At Socrative, however, it obtained a high level of attention which increased the difference with the printed list.

Regarding the difficulties encountered, we highlight the problem of interpreting the phenomena, knowledge gaps and differentiation / reconciliation of concepts. When it comes to the difficulties in interpreting the phenomena, Moreira (2009) states that representations, concepts and propositions are types of meaningful learning that refer to everything that has been learned by the subject. Physical phenomena, therefore, will be interpreted when the student is able to recognize them in a non-arbitrary and non-literal way.

In this case, when presenting knowledge gaps, such as not knowing mathematical proportional relations between quantities, the student A5, for example, presented lower records of his levels of attention. There is, therefore, an indication that the lack of knowledge reduces the subject's attention, for trying and failing to resolve a question in thought. Consequently, the chances of building meaningful learning are reduced. A final situation, however, is the difficulty of differentiating and reconciling concepts.

If the student is unable to differentiate and integrate concepts, when solving questions of any kind, it means that his learning can still be at a mechanical level. However, when resolving issues on Socrative, we find that levels of attention are higher during the development of meaningful learning. First, student A5 appears with the smallest percentage difference in the levels of attention measured in the first and second groups. We can say that this student has possible problems with significant propositional learning, since it is necessary to articulate ideas based on conditional structures. When mentioning that the questions "were very similar", the A5 student realizes some difficulties in establishing a differentiation between the existing knowledge in his cognitive structure with the new knowledge proposed through sentences. In addition, A5 was unable to establish proportional relations between the quantities involved in the questions, which allows us to conclude that in addition to the difficulties with significant propositional learning, the student presents problems related to conceptual conceptual learning. Concepts are the basis for understanding. However, this scenario of difficulties was partially overcome by feedbacks on the issues in the printed list. Added to this is the student's understanding that Socrative makes him more aware and without dispersion. This can be seen by the increase in the percentage differences of the first and second groups. However, in the third group of measures, the percentage difference was greater (greater than 14%), which demonstrates that the A5 student is able, despite the levels of attention being less than 60% in the third group of measures, to include in his cognitive structure some elements that suggest evidence of significant learning to a greater degree.

Then, student A6 mentions the existence of some personal problems that affected her attention while solving the questions on the printed list. However, the results with Socrative and the levels of attention were higher with this one. There are indications of significant conceptual learning. According to A6, Socrative makes her more focused and less tense and this is reinforced by her understanding that the teacher's feedbacks favor new understandings.

Student A4, who obtained the highest percentage differences in the first and third groups, presented significant correlated subordinate learnings, as there was a modification and delimitation of the existing subunits. Like A5, student A4 attributes to teacher feedback and Socrative as elements that favor her attention. In our understanding, attention was also favored by the progressive transition between the new prior knowledge that took her from mechanical learning to meaningful learning.

Student A3, although he did not mention difficulties, was distracted by the different questions on the printed list and the same did not happen when solving the Socrative question.

5. Conclusion

The research presented in this article brings a number of important elements to be discussed in Education. The search for academic excellence involves teaching and learning. A teaching focused on student learning, capable of implementing methodologies that promote engagement in the classroom. Teaching that seeks a significant variety of audiovisual resources, laboratory materials and, mainly, the use of ICT. Mobile devices, in this sense, contribute significantly to the desired engagement by teachers from different areas of knowledge. Devices such as smartphones and tablets, for example, represent the technological world of youth that reaches universities across the country, regardless of social class. Teachers working in higher

education, private and public, confirm this statement. While some reject the use of these technologies in the classroom, there are those who accept their use and include these technologies in our routines, as they know the difference they can and make in student learning.

The results of this research are initial studies that confirmed the expectations and convictions of this quality education sought by teachers in all areas. The Socrative is an application that, through an active work methodology, enhances the attention of students to develop meaningful learning.

From the analyzes carried out it is a fact that the levels of attention fluctuate much more in the resolution of exercises in a printed list in relation to Socrative. The least oscillating cases are present in the measurements obtained with students A1, A2 and A3. We maintain that these few fluctuations between the six levels of attention are directly related to more elaborate and in-depth meaningful learning for these students. In these, knowledge was already assimilated into their cognitive structures. The diversity of subunits that facilitate the understanding of the phenomena allows students A1, A2 and A3 to work with the complexity of subjects related to the mechanics of bodies and particles.

The engagement process with Socrative, free of distractors as a "polluted" list of questions to be evaluated, coupled with the teacher's feedbacks, enrich and sustain the knowledge of students A1, A2 and A3 which allowed us to observe the evidence of learning more elaborate changes throughout the research. These are possible to be observed by the constant availability of exercises that the teacher prepares for his students. These are questions elaborated from their previous knowledge. Such issues are rebuilt to new knowledge, increasingly complex, are contemplated to the extent that significant learning indicia to be checked by the teacher. Attention plays a fundamental role in this process. And this is favored when the material prepared by the teacher is rich in situations that lead him to think and reflect on the existing knowledge and the new knowledge provided by the teacher. The Socrative is therefore an integral part of the potentially significant material prepared by the teacher, as with the application, the student's attention is focused on a single issue. And, to promote student learning, it is not enough to have potentially significant material. There needs to be interaction between the teacher and his students in the classroom.

However, if the teacher does not produce potentially meaningful material, engagement and attention will be reduced. In order to keep attention levels high in this type of work, we suggest that the teacher always have a database with different types of questions and that involve all types of meaningful learning. Feedback should be a constant practice. The teacher needs to go beyond correction to the right answer in this feedback. It is also necessary to present the ways that invalidate the answers.

We intend, in future works, to extend and investigate attention in this and other teaching and learning contexts. This initial study can be extended to other forms of interaction between subject and object. The subject as the one who learns and object as what one wants to know and learn. The means of learning are varied. Movies, books and interactions between subjects are means by which it is possible to develop different forms of Meaningful Learning. In this sense, investigating attention with these different ways of learning is a necessity so that we can understand how a student builds his knowledge. And yet, what forms (videos, reading, software, etc.) that most favor a student's attention when he is in the learning process.

Finally, in future works, it is desired to increase the number of subjects to prove the relevance

of the findings of this investigation. In addition to this expansion, the intention is to investigate attention in the fields of neuroscience, seeking partners from different areas of science, such as biology and psychology. The existence of other factors that influence attention, such as human physiology and psychological states, are relevant according to studies published by these areas. One of the initial hypotheses would be to verify the relationship between the feelings of pleasure with the students' attention and the acceptance of the Socrative App, since there may be a close link between them. This is in line with related studies (FEUERSTEIN, 1980; SCHACTER, 1996; SCHULTZ, 2007) that highlight the role of dopamine, the neurotransmitter responsible for sensations of pleasure, attention and cognition, among others, which comes into play for internal motivations and external to individuals.

6. Acknowledgement

Federal Institute of Rio Grande do Sul (IFRS), Brazil
Federal University of Rio Grande do Sul (UFRGS), Brazil
Pontifical Catholic University of Rio Grande do Sul (PUC-RS), Brazil

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