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CONCEPTUAL PROFILE OF FORCE: AN ANALYSIS OF DISCURSIVE INTERACTIONS INTHE CLASSROOM USING ACTIVE METHODOLOGIES

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ABSTRACT

This research analyze the evolution of the conceptual profile of Force of high school students at the Instituto Federal de Educação, Ciência e Tecnologia do RioGrande do Norte - IFRN, campus Mossoró, when submitted to a didactic sequence based on active methodology. We integrated the Conceptual Profile Theory to a discourse analytical structure tool, allowing to follow the interactions and dynamics of the conceptual profile of the students throughout theproduction and dialogic exchange of meanings. Data were collected through: two questionnaires, which were categorized accordingto the zones of a conceptual profile model of Force; logbook; and video recordings of the classes. We selected and analyzed some teaching episodes. With the results achieved, we infer that the teaching proposalbased on active methodology favored interactions and the evolution of the conceptual profile of the physical concept of Force in the classroom.

KEYWORDS: Conceptual Profile of Force, Active Methodologies, Discourse Analysis in the Classroom

PERFIL CONCEITUAL DA FORÇA: UMA ANÁLISE DAS INTERAÇÕES DISCURSIVAS EM SALA DE AULA COM O USO DE METODOLOGIAS ATIVAS

RESUMO

Esta pesquisa analisa a evolução do perfil conceitual de força de alunos do Ensino Médio do Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte - IFRN, campus Mossoró, quando submetidos a uma sequência didática baseada em metodologia ativa. Integramos a Teoria do Perfil Conceitual a uma ferramenta de estrutura analítica do discurso, permitindo acompanhar as interações e dinâmicas do perfil conceitual dos alunos ao longo da produção e troca dialógica de significados. Os dados foramcoletados por meio de: dois questionários, os quais foramcategorizados de acordo com as zonas de um modelo de perfil conceitual de força; diário de bordo; e gravações em vídeo das aulas. Selecionamos e analisamos alguns episódios de ensino. Com os resultados alcançados, inferimos que a proposta de ensino baseada na metodologia ativa favoreceu as interações e a evolução do perfil conceitual do conceito físico de força em sala de aula.

PALAVRAS-CHAVE: Perfil Conceitual de Força, Metodologias Ativas, Análise do discurso em sala de aula.

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1 INTRODUCTION

To teach science, especially Physics, is a complex task. It requires us to look at three distinct and complementary dimensions: *concepts, procedures and attitudes.* Each of these dimensions alone is insufficient to fulfill the mission to educate scientifically, but together, they enable constituting individuals capable of actively participating in the society they belong to.

However, it cannot be denied that given the current models of teacher qualification, teaching Physics is still almost exclusively teaching concepts. Therefore, it is frustrating to observe that, despite the importance we give to this conceptual dimension of teaching, we still do not get the results we want. Many teachers perceive and experience that "[...] most students do not learn the science they are taught" (Pozo & Crespo, 2009, p. 15).

When it comes to criticism, when speaking effectively of the classroom space, many refer to the famous "Traditional Teaching Model", which is the teaching model in which the student's participation is reduced to receiving ready and finished information given generously by the teacher – the model of banking education Freire (1997) talked about so much. A central characteristic of this model is the fact that it attributes a *tabula rasa* character to the student. Therefore, the adept teacher shall "write" on that white board everything he intends the students to master.

However, many studies, mainly started in the second half of the twentieth century, (Tiberghien, 1985; Driver, 1989; Driver, Guesne & Tiberghien, 1992), point to the fallacy of *tabula rasa* and categorically state that the students have their own ideas which have to be taken into account somehow during the teaching and learning process - the origins of these Alternative Conceptions have are sensory, cultural and school (Pozo & Crespo, 2009). Thus, since the students are not *tabula rasa*, but rather a big blackboard already scribbled with their own ideas, theories and models begin to surge (Theory of Meaningful Learning, Model of Conceptual Change and Conceptual Profile Theory) which aim to think about the teaching and learning process based on alternative conceptions. In parallel, new teaching methods are also emerging, seeking to make the classroom a more attractive and favorable environment for this process - these are the Active Methodologies (Fagen *et al*., 2002; Malheiro & Diniz, 2008; Marques *et al*., 2018; Jorge Benevides *et al*., 2021; Rojas-de-Gracia *et al*., 2022).

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In this paper, we will present the result of a study which, using the Conceptual Profile Theory (Mortimer, 1995) as support, sought to analyze the construction of the physical concept of Strength in classes based on Active Methodologies. Therefore, the question that guides this work arises, namely: Is it possible a teaching proposal based on Active Methodologies to favor the interactions and the evolution of the conceptual profile of the physical concept of "strength" in the classroom? To answer this question, we set the following general goal: To analyze theevolution of the conceptual strength profile of students submitted to a didactic sequence based on Active Methodologies in the classroom discourse. To make this goal feasible, we sought to: i) know and analyze the previous conceptual profile of the physical concept of strength of students in the first year of high school; ii) observe the application of a didactic sequence - Active Learning Unit (ALU) (Coelho, 2019) – in subject Physics; and iii) assess the discursive interactions and check the evolution of the conceptual strength profile from ALU.

2 CONCEPTUAL PROFILE THEORY

It is possible to think about the relationship between what the students know (their alternative conceptions) and what is intended to be taught (scientifically accepted knowledge) from three different perspectives: i) the alternative conceptions of the student and the scientifically accepted knowledge are of the same epistemological, ontological and conceptual nature. Therefore, they are compatible. In this perspective, teaching science would be a simple process of training the students in the methods of science. This way of thinking is very close to what underlies the Theory of Meaningful Learning (Ausubel, 1982); ii) the student's alternative conceptions and scientifically accepted knowledge are of distinct epistemological, ontological and conceptual nature. Therefore, they are not compatible. From this perspective, teaching science means extinguishing alternative conceptions and replacing them with scientifically accepted ones. This way of thinking is what underlies the Conceptual Change Model (Posner *et al*., 1982); and finally, iii) the student's alternative conceptions and scientifically accepted knowledge can be hierarchically integrated according to their contextual utility. From this perspective, teaching science means expanding the meanings of its alternative conceptions (to include scientifically accepted conceptions) and giving students metacognitive conditions to comprehend the context and select the most appropriate meaning for the use of the concept.

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This way of thinking is at the base of the Conceptual Profile Theory (Mortimer, 1995).

> Considered as the first stage of the hierarchical integration hypothesis, there is the idea of independence or use of knowledge according to the context. According thereto, there is no need for the students to ignore their common knowledge and there is no need for a conceptual change. Instead, there is the need for the individuals to become aware (explicit), by means of a metacognitive process of their epistemological, ontological and conceptual assumptions, in order to be able to decide when to use such knowledge according to what the context requests, learning to activate it at the right time (Sousa, 2022, p. 18).

It was thinking in this way that Mortimer (1995), based on the idea of Epistemological Profile of Bachelard (1940), built the notion of Conceptual Profile. This notion seeks and defends that the world can be seen and represented in different ways due to the persistence of alternative conceptions.

The research on conceptual learning has revealed the strength and the persistence of the alternative conceptions. On one hand, their strength impedes subsumption to work in the way proposed by Ausubel (Ausubel, 2003) in his Theory of Meaningful Learning. Several studiesshowed (Inhelder & Piaget, 2003; Pozo & Crespo, 2009) that the structural character of prior knowledge and the strength of this structure modified the new knowledge and reinterpreted it in terms of prior knowledge and not the other way around, as Ausubel proposed.

On the other hand, the persistence of the alternative conceptions impedes them to be simply replaced by scientifically accepted knowledge as proposed by the Conceptual Change Model, even in cases of intense specialization. In this context, currents of thought emerge to seek to comprehend learning as integration of the two forms of knowledge (Mortimer, 1995; Pozo & Crespo, 2009). According to these ideas, learning is acquiring new meanings for the concepts with no need to waive to previously acquiredmeanings.

The Theory of Conceptual Profiles emerges in this scenario, based on the idea of the Epistemological Profile developed by Gaston Bachelard (1978). For him,

> [...] a psychology of the scientific spirit should outline what we will call the epistemological profile of the different conceptualizations. By means of such mental profile, the psychological action of the different philosophies in the work of knowledge could be measured. [...] We insist on the fact that an epistemological profile must always

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> refer to a designated concept, that it is valid only for a particular spirit examined at a particular stage of its culture. This double particularization makes an epistemological profile interesting for a psychology of the scientific spirit (p. 25).

Bachelard's idea is that it is not possible to explain the richness of the conceptual thought from a single philosophical current (naive realism, clear and positivist empiricism, classical rationalism, complex rationalism, discursive/dialectical rationalism). For him, each individual has an epistemological profile for each concept, where shades of each of these philosophical currents (to a lesser or greater extent) contribute to the entire spectrum of meaning of the concept.

Based on that, Mortimer (1995) develops the idea of the Conceptual Profile.

> For him, the conceptual profile of given concept, in each individual´s vision, can be related to several contexts and present different characteristics, so that any individual can indeed have several conceptions to comprehend reality, which can be used in contexts and situations he considers convenient (Sousa, 2022, p. 21).

Mortimer (1995, p. 273) defines the term “conceptual profile” as a “supra-individualsystem of ways of thinking” in which each individual will obtain their own meaning for given concept/action, generating different representations that relate to what he called profile zones. That is, each individual´s “ways of speaking” (Mortimer, 1995) are individual and unique; however, there are epistemological, ontological and conceptual regularities that enable us to group these ways of speaking and thinking into zones of conceptual profile.

Thus, learning physics would consist in making the students' conception profile evolve. In this context, new ideas are acquired in the teaching-learning process, generating an interweaving between the daily ideas (alternative conceptions) and the scientific ideas.

The main difference between Bachelard's notion of epistemological profile and Mortimer's conceptual profile is that, for the latter, “[...] their 'pre-scientific' levels are notdetermined by philosophical schools of thought, but by the individuals´ epistemological commitments, ontological aspects” (Mortimer, 2000. p. 78).

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> Thus, the elucidation of the students' conceptual profiles aims to structure the ideas and the conceptions of the individuals in different areas that represent different ways of defining and discussing certain concept, as well as the epistemological and ontological principles which have led them to build these profiles. Each of these profile zones corresponds to a way of thinking and talking about the representation of reality, which coexists with other different forms in the same individual. The conceptual profile can be an auxiliary tool for planning and analysis of the science teaching (Sousa, 2022, p. 21).

Thus, based on that, the obstacles to the scientific concepts learning can be identified and worked on in the classroom (Almeida Guimarães *et al*., 2023) considering science learning as evolution of conceptual profiles, where the student does not necessarily have to abandon their ideas and conceptions when learning new scientifically accepted ideas, but become aware of the different existing zones and the relationship between them in the different types of contexts and situations.

2.1 A Model for the Conceptual Strength Profile

In this section, a conceptual profile model for the physical concept of Force will be presented, present in the literature. Radé (2005) built such a conceptual profile consisting of eight categories. These categories represent the different zones of the conceptual profile elaborated from an epistemological matrix as established by Santos (2005). This matrix presents a historical-epistemological perspective of the concept according to Jammer (1957), psychogenetic-developmental according to Piaget (1973) and psychogenetic-historical according to Piaget and Garcia (1983), as well as a perspective of the alternative conceptions of the concept according to research carried out in the area.

It is important to highlight that based on the analysis of the mentioned perspectives that make up the epistemological matrix and the goal to promote a representative panorama of the concept of Strength upon epistemological and ontological biases, Radé (2005) identified the following zones for the concept of strength:

> I: notion of strength originated from the perception of our physical, muscular effort; anthropomorphic, animistic; indistinct of energy, effort, work, potency, power and motion; II: dual strength (opposites in conflict), regulatory, of divine origin, inherent to matter, acting by contact; III: strength as 'sympathy' (attraction of the similar), corporeal,inherent to object, of divine nature or origin, acting at a distance. Resistance to object motion as strength (*vis resistiva*); IV: immaterial strength, subject to mathematical formalization. Strength as a sequence of joined instantaneous, external impulses. Centrifugal Force, real, as a regulator of the circular motion of bodies; V: strength as an a priori concept. Strength

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> as a property of resistance inherent to matter (inertia) or as a Force impressed by external action, this vector, composable according to the parallelogram rule, causal agent of acceleration, acting in pairs of action and reaction, possibly at a distance, but through ethereal spirits, forming a 'Force field'; VI: Forces such as exchanges of virtual particles (pion, photon, W/Z and graviton) in Quantum Mechanics; VII: Force in Special Relativity analogous to the Newtonian Force; however, related to relativistic mass, depending on speed and not inertial mass, at rest. However, in general, acceleration is not co-directional to Force and the action at distance is not instantaneous, but propagates limited by the speed of light; and VIII: Force as the deviation of the body from its natural path (geodesic) in space-time in General Relativity.

From this characterization, we can understand the students' ways of thinking and speaking related to the physical concept of Strength. To be aware this richness of meanings enables the teachers to "prepare a more effective teaching plan, facilitating their task in the sense of making the students evolve into categories of successively increasing explanatory power, from the concept of Strength, from the point of view of science" (Radé , 2005).

2.2 Active Methodologies

Active Methodologies is an expression which has been constantly used to designate any set of practices in the classroom the main objective of which is to distance the students fromtheir passivity, giving them more active and autonomous role in the teaching and learning process.

Thus, Active Methodologies are used with the purpose "students and teachers to be able to have maximum control over their teaching and learning processes and better use thereof" (Coelho, 2019, p. 204). Therefore, this conception is characterized by placing the students as the main agent of their learning, making them recognize their importance and the need to participate actively, in order to develop critical, interactive conscience and integral qualification. For better comprehension, Coelho (2019, p. 205) highlights that Active Methodologies

> [...] aim to transform the teaching and learning process into a dynamic act, where the main actor is not the teacher any more. In this scenario, the students undertake the role of builders of their own knowledge, and the teacher, the provider of adequate means and procedures for the students to achieve their goals.

In the national and international literature, it is possible to find huge diversity of proposals for Active Methodologies (Fagen *et al*., 2002; Malheiro & Diniz, 2008; Marques *et al*., 2018; Jorge Benevides *et al*., 2021; Rojas-de-Gracia *et al*., 2022). At IFRN-Mossoró, Coelho (2019) developed the idea of Active Learning Units.

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2.2.1 Active Learning Units (ALU)

AAU can be defined as

> a set of materials prepared and/or selected by the teacher, accompanied by a set of guidelines through which the student will start, individually and subsequently, with guidance by the teacher, the learning process of the didactic content intended to be worked on in the classroom (Coelho, 2019, p. 205).

Therefore, it is understandable that, in relation to its elaboration, the teacher aims at the student's protagonism, considering that, in other words, as the author observes "ALU is built in a way that the student is invited to start the process up" (Coelho, 2019, p. 206). During the process, the idea is the students to be able overcome their doubts and difficulties, so that they can achieve both the construction of their own knowledge, and the feeling of satisfaction during their learning.

To what refers to the role of the teachers, they must act as mediators/articulators of knowledge, seeking and proposing strategies outlined in their elaborations and applications of the materials developed and selected to compose (ALU). Thus, it is important the teacher toguide the students and contribute with situations that can promote achievement of the goal in given task, and recognize the phenomena and solve the presented problems.

However, it is necessary to keep in mind some characteristics and purposes of an Active Learning Unit. Coelho (2019) highlights, for example:

i) The specific texts, intended for content of ALU - the students must have access to the text to study before class;

ii) Video classes - these shall also be made available in advance, in order to help for better comprehension after reading the text, contributing for the students to be able seek to solve the questions present in the read/studied text later;

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iii) The reading tests (low complexity and with objective questions) – in the first meeting, in the classroom, the teacher applies them in order to make sure that the students have had contact with the materials made available in advance and that they have successfully comprehended the main idea of the content;

iv) Conceptual tests (with certain complexity and multiple choice) – in this test, associations/relationships the students establish with the concepts involved in the content can already be demanded. At this point of the class, the class adopts attitude similar to the *Peer-Instruction* methodology (Coelho, 2018), as follows:

a) Initially, each student receives a Plicker card (QR-Code) – Figure 1 – which identifies them at the homonymous software;

b) The teacher designs the reading tests and gives the students some of time to develop their answers;

c) At the end of the time, with the help of smartphone, the teacher collects the answers of all students and checks the percentage of hits of the class;

d) If this percentage is greater than a limit value (determined by the teacher as satisfactory), he moves on to the next problem;

e) If the percentage is greater than a limit value (determined by the teacher as critical), the teacher explains the problem and requests a new answer from the students;

f) In case the percentage of answers is between the minimum critical value and the maximum satisfactory value, the teacher gives the students time to discuss the problem in between and repeats the question.

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v) Conceptual and mathematical problems (of higher complexity) – in the second meeting, in the classroom, the aim is to enable/create time for conversation with the students to discuss the obtained answers.

The author also points out the use of videos and animations during the process, as well as didactic experiments and computer simulations. Regarding the assessment mode, he indicates it as continuous based on the considerations and the results achieved by the students throughout the course of implementation of the Active Learning Unit (ALU).

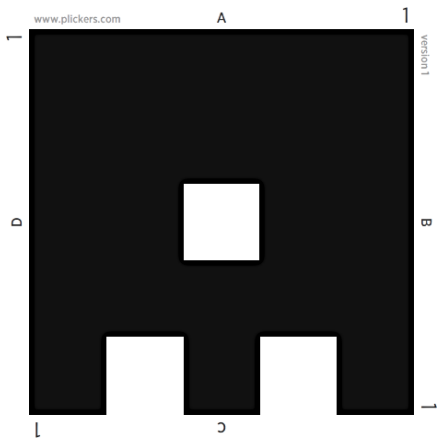

Figure 1: Model of one of the Plicker cards given to students for collection of the answers to the conceptual tests. Source: <https://help.plickers.com/hc/en-us/articles/360008948034-Get-Plickers-Cards> Access on 01/11/2003

3 METHODOLOGY

3.1 Classification of the research

This research is defined as qualitative, considering that "[...] it is concerned about analyzing and interpreting deeper aspects, describing the complexity of human behavior. It provides more detailed analysis of the investigations, habits, attitudes and behavioral trends" (Marconi & Lakatos, 2008, p. 269).

It seeks to comprehend the reality of the discursive interactions in the classroom around the physical concept of Strength, and therefore, it is classified as a case study, a method that can be understood as a deep study (whether about an individual, a group, an organization or a

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phenomenon) which, in turn, can be applied in different areas of knowledge (Gil, 2017).

3.2 Research subjects and context

The research was carried out with 13 students enrolled in the 1st year of high school at the Federal Institute of Rio Grande do Norte - IFRN, located in the city of Mossoró/RN. It should be pointed out that the number of students present in the classes varied, once the participation of the students was voluntary. ALU, as well as the intervention, was carried out by the Physics teacher at the institution. There were 6 extra-class meetings (the first and last for application pre-and post-tests) held once a week, lasting an hour and a half, between June and July 2022.

3.3 Research procedures

3.3.1 Actions, interventions and intentions

The research was carried out at three different times, namely:

i) application of a pre-test, composed of objective and dissertation questions, the purpose of which was to investigate the conceptual profile of the students related to the physical concept of Strength before any intervention by the teacher. The pre-test questions were proposed and made available by Radé (2005);

ii) intervention and observation, when the teacher worked with the students on the proposed teaching methodology (ALU) and when videos and notes in logbook were recorded, with the intention to enlighten the dynamics of the zones of the conceptual profile of Strength during the dialogue interactions in the classroom;

iii) application of a post-test, consisting of dissertation questions only, the purpose of which was to comprehend which prior obstacles the students overcame and how their conceptual profile evolved after the intervention. The post-test questions were based on the Inventory of Basic Conceptions Mechanics – IBCM (Halloun, 2007).

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3.3.2 Analyses of the collected data

i) Analysis of data from the pre- and post-test questionnaires

The pre-test consisted of 12 questions (1, 2, 3, 4, 8, 9, 10, 11 and 12 objective and 5, 6 and 7 dissertation questions). The objective questions did not contain a defined number of items. Each question proposed items (a, b, c, d, etc.) that sought to contemplate all possible shades of the students' alternative conceptions. Each of these items was categorized according to the ideas proposed by Radé (2005) – Table 1.

Table 1: Zones and conceptions of the conceptual strength profile. Categorization of the pre-test objective items

Zone	Conceptions	Question/Alternative
I	Indistinct notion; animist and anthropocentric.	
II	Dual strength, regulating, of divine origin, inherent to matter, acting by contact.	
III	Strength as 'sympathy', corporeal, inherent to the object, of divine nature or origin, acting at distance.	
	Resistance to the object motion as strength (*vis resistiva*).	3e
	Intrinsic gravity to mass	2c;1a
	The greatest Force determines the motion	4ª
	Commitment of Forces determines the motionLast Force to act determines the motion	8d; 12a 11a 12e
	Only active agents exert Forces	
	Motion implies active Force	
	Lack of motion implies lack of Forces	8b
	Speed proportional to the applied ForceGreater mass means greater Force	8c 2c,d,e 8e; 12ª
	The most active agent produces the greatest Force	11a,b
	Centrifugal Force	12c
	Obstacles do not exert Force	
	Mass makes objects stop	
	Gravity helped by air pressure	
	Functional vision of strength	
IV	*Impetus* provided by impact	11d
	Impetus loss/recovery	2d, 4c,e
	Impetus dissipation	3a,b,c; 1c;11b
	Gradual/delayed build-up of *impetus*	4d; 11e
	Circular *impetus*	2a,d
	Gravity works after *impetus* is depleted	1c

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V	Newton's First Law Newton's Second Law Newton's Third Law Vector Force, composable according to the parallelogram rule. Relational vision of Force Newtonian view of Force Passive Force of contact with solid Friction opposes motion Thrust Force of contact with Force Gravitation Parabolic trajectory of the projectile	2b; 4b 4b 8a 7 12b,d 11c 12d 12b,d; 3d 1b
VI	Exchange Forces (interaction) between particles Exchange Forces (interaction) between particles	
VII	Relativistic Force	
VIII	Force as curvature of space	

Source: adapted from Radé (2005).

In the analysis of the dissertation questions, we looked for the presence or absence of the characteristics listed in Table 1 as indicator of the presence or absence of certain zone in the students´ expression. From the analysis of the students' answers, it was possible to see the Extension of the Profile Zone (EZP), a number which shows the intensity of emergence of each zone of the Strength profile in the students' way of thinking and speaking. Each time the student expressed an answer with characteristic of one of the zones in an objective or dissertation question, 1 point was added to that zone. In the end, the number of occurrences in that zone constituted what we call EZP. The post-test consisted of 14 questions, all dissertation. The analysis was made in a similar way to that of the dissertation questions of the pre-test.

ii) Qualitative study of the discursive dynamics

In order to analyze the dynamics of the discourse, we use video recordings of the classes. The video recorded data was revisited several times by the researchers in order to select adequate teaching episodes for analysis. Once the teaching episodes were selected, each one of them was transcribed, according to Marcushi (2000).

To analyze the data collected this way, we used the analytical structure of the discourse proposed by Mortimer and Scott (2002; 2003). With this tool, we sought to characterize the ways

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how teachers and students interact during the process of producing new meanings using the language. This tool proposes observation of five different aspects of interactions (Chart 1).

Chart 1: Aspects of the discourse analysis developed by Mortimer and Scott (2002; 2003)

I. Teaching focus	II. Approach	III. Actions
1. Teacher's intentions	3. Communicative approach	4. Interaction patterns
2. Content		5. Teacher´s interventions

We emphasize that in this work, we kept our analysis linked to the first four aspects. In Chart 2, we present the categories for each observed aspect.

Chart 2: Categories of the analyzed aspects

Teacher's intentions	Content	Communicative approach	Interaction patterns
- create a problem - explore and/or check the students' ideas - introduce and develop the 'scientific story' - guide the students in working with scientific ideas - support the internalization process - guide the students in applying scientific ideas and expanding their use, progressively transferring control and responsibility for that use to them - keep the narrative, sustaining the 'scientific story'	- description - explanation - generalization	- interactive/dialogue - interactive/authoritative - non-interactive / dialogue - non-interactive/authoritative	- I – R – A - I – R – F – R – F... - I – R – P – R – P...

The first aspect (teacher's intention) is related to what the teacher intends when starting or keeping interaction.

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The second aspect deals with the type of content worked on during the interaction. The first category (description) encompasses statements that refer to a system, object or phenomenon, in terms of its constituents or the spacial-temporal displacements of these constituents. Regarding the second category (explanation), the content of the discourse is about imported theoretical models or mechanisms to refer to specific phenomena or systems. The third category (generalization) contemplates the two previous categories,i.e., when the statements refer to descriptions and explanations that are independent from a specific context, the content in classroom turns to generalization.

The third aspect of the analysis deals with the communicative approach. It refers to the way how the teacher conducted the construction of meanings, allowing or not the students to speak. By means of that, it is possible to identify and understand whether: i) there is interaction between them (teacher and students) and whether ii) the teacher considers or not the students' ideas in the process of construction of meanings in the classroom. Still on the communicative approach, it can be characterized based on two axes, namely: dialogue or authoritative discourse and interactive or non-interactive discourse. Thus, briefly, each of these four classes can be defined as Mortimer and Scott (2002) point out, namely:

i) interactive/dialogue: Participation of more than one person is noticed. Commonly, the teacher and the students explore ideas, formulate authentic questions and offer, consider and work different points of view in the interaction.

ii) non-interactive/dialogue: Only one person is involved; however, it is considered from more than one point of view. Commonly, the teacher summarizes several points of view, highlighting similarities and differences.

iii) interactive/authoritative: Interaction of more than one person is perceived, but only one point of view is considered. Commonly, the teacher leads the students through a sequenceof questions and answers with the purpose to get at a specific point of view, which is usually that of the school science.

iv) non-interactive/authoritative: Only one person presents statements and only one point of view is considered. Usually, the teacher presents a single specific point of view, which is usually that of the school science.

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The fourth and last analyzed aspect deals with the interaction pattern. It expresses the cadence of interactions, highlighting who is speaking and what type of speech was produced at each round of the interaction. In this context, according to Mehan (1979), Mortimer and Scott (2002; 2003), there are two more common categories within this aspect, I-R-A triadic pattern which encompasses the initiation by the teacher (I), the students´ response (R) and the assessment by the teacher (A), and the non-triadic interactions (in chains) I-R-F-R-F... where the teacher provides feedback (F) with the intention the students to elaborate their explanation/speech better, and I-R-P-R-P, in the which the teacher performs a discursive action enabling the students to continue (P) with their explanation/speech. The authors also point out that these chains can be closed when they are finalized by assessment (A) by the teacher or opened when the teacher does not do that.

Mehan (1979) further expands the characterization of the interaction patterns in the classroom with four types of initiation (I), two types of answers (R) and two types of assessment (A) and continuation (P) as shown in Chart 3 below.

Chart 3: Categories for the characterization of the patterns of interaction in the classroom

Types of initiation	
Initiation of choice (Ie)	The feedback must be to agree or disagree.
Product Initiation (If)	The feedback must be a factual answer.
Process initiation (Ip)	The feedback represents an opinion or interpretation
Metaprocess initiation (Im)	The feedback is a reflection on the process.
Types of answers	
Relates to initiation (R)	It reflects the type of initiation made, and could be a choice, a factual answer, an opinion or interpretation, or a reflection on the process.
Regarding the assessment	Complete answer Partially complete answer Incorrect or asymmetric answer No answer.
Types of assessment and follow-up	

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Positive assessment (A)	Ends the sequence.
Continuation (P)	Negative feedback. Repetition of initiation. Simplification of initiation. Others.

Source: Amaral and Mortimer (2007).

Finally, this whole structure enabled us to understand deeply the movement of construction of meaning which was processed while teacher and students dialogged on the subject in the classroom.

4 RESULTS AND DISCUSSIONS

4.1. Pre-test questionnaire

The students' conceptual Strength profile was initially “measured” with the pre-test. For the 13 students who answered, Chart 4 shows which area of the profile they expressed in each given answer.

Chart 4: Zones of the conceptual profile of strength emerged in the participating students´ answers to the pre-test

Questions	Students												
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
1	Z5	Z5	Z5	Z5	Z5	Z5	Z5	Z5	Z3	Z5	Z5	Z5	Z5
2	Z3	Z4	Z3 Z4	Z3	Z4	Z4	Z4	Z3	Z3	Z3	Z3	Z5	Z5
3	Z4	Z4	Z4	Z4	Z4	Z4	Z4	Z4	Z5	Z4	Z5	Z4	Z4
4	Z3	Z5	Z4	Z3	Z3	Z3	Z5	Z3	Z5	Z5	Z5	Z3	Z5
5	Z3	Z2	Z2	Z2	Z2	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3
6	Z2	Z2	Z2	Z2	Z2	Z2	Z4	Z3	Z2	Z2	Z2	Z5	Z2
7	Z3 Z5 Z3	Z5 Z2Z 2	Z2	Z5	Z2	Z2 Z5 Z3	Z5	Z2 Z5	Z3 Z5 Z2	Z5 Z5 Z3 Z5	Z5	Z3 Z5	Z5 Z3 Z2
8	Z5	Z3	Z3	Z5	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3
9	Z3	Z5	Z3	Z5	Z5	Z5	Z3	Z5	Z3	Z5	Z5	Z3	Z5
10	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z5
11	Z5	Z3	Z3 Z4	Z3 Z4	Z3 Z4	Z3 Z4	Z3	Z3 Z4	Z3 Z4	Z3 Z5	Z5	Z3	Z5
12	Z5	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z3	Z5	Z3	Z3	Z3

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Figure 2 presents EZP of each student. The information explained in Figure 2 below shows that different zones emerged, except zone 1, which was omitted, due to the fact that, in none of the students' answers, there was manifestation of this way of thinking about the concept of Strength. In turn, we can conclude that, although students A10, A11 and A13 stood out for presenting ideas corresponding to the Newtonian zone (zone 5), ideas representing the pre-scientific period (zone 2 and zone 3) were predominant. Students A1, A2, A3, A5, A6, A8, A9 and A12 are included in this category. Within them, it is observed that students A3, A5, A6 and A8 also stand out, together with student A7, for presenting ideas representing the pre-Newtonian category (zone 4).

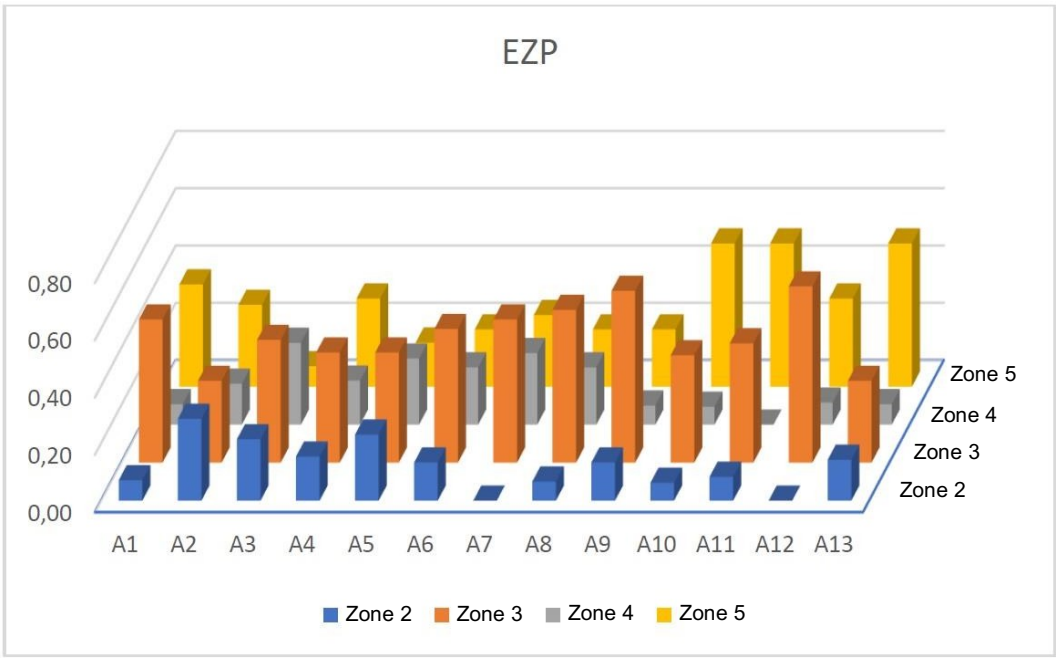

Figure 2: Presentation of the individual conceptual profiles of the students participating in the pre-test

4.2. Discourse analysis

For discourse analysis, we selected two teaching episodes. The first was selected while the professor was working on the conceptual tests (4th aspect of the ALU – see above). The second was selected when the teacher worked on solving conceptual and mathematical problems (5th aspect of ALU – see above).

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Chart 5 below presents the transcript of teaching episode 1. This episode deals with the solution of a conceptual problem with plicker cards. It discussed the situation of a Force applied to a car, initially stopped on an air mattress track. The Force acts during certain time giving the car certain final speed. The question is what should be the time a second Force (with half the intensity of the first) should be applied for to reach the same final speed. The teacher's intention was to explore the students' ideas about Newton's Second Law. The *content approach* was explanatory.

Before any interaction with the students, the teacher asked them to answer to the problem based on their previous impressions. The hit level of the class was 60%. After that,during some time of discussion among themselves, the students expressed the following lines:

Chart 5: Representation of episode 1

Lines	**Interaction pattern**
1. P: At this point, I want you to exchange ideas with each other, to try to convince your classmates about your answer. Then I will collect your answers again.	I
2. A8: Which alternative did you choose?	R_8
3. A4: Alternative B.	R_4
4. A8: What about you?	R_8
5. A7: Alternative A.	R_7
6. A8: I marked C. ((Students A8, A4 and A7 laugh)).	R_8
7. A7: Which one did you choose?	R_7
8. A15: Alternative A. ((Student A7 celebrates!))	R_{15}
9. A6: I'm using a Force, (+) but it's half of what I used before and I want the speed to be the same...	R_6
10. A8: Speed?! ...	R_8
11. A6: I don't have to apply Force longer, do I?!	R_6
12. A5. If we double the acceleration...	R_5
13. A6: Because, if not, it will stop before, won´t it?!	R_6
14. A16: I misread the question/	R_{16}
15. A8: ((Reads the question:)) *the friction between the car and the track is negligible* (...)	R_8
16. P: Is anyone going to change the answer? (+) A4 has already changed! Is anyone else going to change the answer? (...) Now, yes! 100% hits.	A

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Initially (round 1), the teacher encourages the students to analyze the problem situation. In rounds 2 and 4, student A8 questions his classmates A4 and A7 about the answer provided to the teacher through the QR Code. At the time of round 6, student A8 is surprised because he provided a different answer from his classmates. Student A7, realizing that the three of them (A4,A7 and A8) provided different answers, (A4 and A8 (zone 3) and A7 (zone 5)), gets up and goes to the chair of another classmate A6, who in turn, starts explaining his point of view (zone 5), as presented in round 9.

Round 9, as well as the explanation given by student A6, was determining in this episode because, in addition to causing the following rounds (9-15), such interpretation stands out as it is directed at the way of thinking about the concept in question according to Newton's second law (zone 5). As a result, at the end of the episode, the students who had presented (through their individual analysis of the problem) answers different from the expected ones, were able to interpret the problem, understanding that the referred second Force should be applied during an interval with twice the time of application of the first Force (alternative A). Then, the level of hits increased to 100%.

Chart 6 below summarizes episode 1 in terms of all aspects of interest:

Chart 6: Summary of the analysis of teaching episode 1

Rounds and subjects	Profile zone	Content approach	Teacher's intentions	Communicative approach	Interaction patterns
Round 1	-	-	Explore the students' ideas	NI/A	I
Round 2 - 8	3	Descriptive and Theoretical Explanation	Explore the students' ideas	I/A	R_8, R_4, R_8, R_7, R_8, R_7, R_{15}
Round 9 - 15	5	Theoretical Explanation	Explore the students' ideas	I/A	R_6, R_8, R_6, R_5, R_6, R_{16}, R_8
Round 16	-	-	Keep the narrative	NI/A	A

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In Chart 7, there is representation of the second selected teaching episode. It is important to point out that the episode was produced when the teacher questioned the alternative found by one of the groups (round1), when the following situation was imposed to him: each member of the group had to imagine themselves sitting on a chair, with their hands tied, in the middle of a frozen lake, and in front of them, within reach of their feet, there was a crate. Furthermore, without the possibility to walk on this lake, because it is assumed that the friction between any surface and the ice is very nearly zero, how to reach the margin of the lake?

Chart 7: Representation of episode 2

Lines	**Interaction pattern**
1. P: ((Read the statement of the problem)). Shall we discuss your solution?	Ip
2. A4: We thought about exerting a Force on the crate, according to Newton's third law, it will exert a Force back. Then, as the friction is approximately zero, we think about the law of inertia, we will remain in the same state until...	R_4
3. P: I understood! Did you understand what she said?	P
4. A16: More or less!	R_{16}
5. A15: Yes. More or less!	R_{15}
6. A14: He will kick the crate and it will slide away.	R_{14}
7. P: Here's the crate in front of her ((simulating the situation)), she's sitting with her hands tied and she's going to kick the crate. She will push the crate! She argues that by doing this, she is putting a Force on the crate and by Newton's third law, the crate reacts and pushes her backwards. And since there is no friction, this Force the crate will exert on her is necessary to accelerate the chair with her to the margin of the lake, until a Force appears and makes her body and the chair stop. And then?	P - Ip
8. A14: Is the crate stuck?	R_{14}
9. P: No, no. The crate is just there, still.	P
10. A14: Ah, ok!	R_{14}
11. P: If it were stuck, it would be even better, wouldn´t it?!	Ie
12. A14: It was, it was.	R_{14}
13. P: But what she said makes sense, doesn´t it?! (+) it makes perfect sense! Because you're on the chair, tied up and you push the crate. You exert Force on the crate. And then, the crate will accelerate to that direction, wont´it?!	F
14. A7: Yes!	R_7
15. P: Accelerate while you are pushing. After you stop pushing, what happens to the speed of the crate? (+) After your feet come off the crate, what happens to it? Does it stop immediately?	F
16. No! ((answer from all students))	R
17. A14: No! It goes away! (...)	R_{14}
18. P: It will go away at constant speed, right?!	P

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19. A14: So, there is only one chance. If you make a mistake, you die!	R_{14}
20. P: If you make a mistake, game over! You will stay there, dying freezing ((all laugh))	P
21. P: And, of you exerted Force on the crate, obviously, the crate exerts Force on you. These two Forces, what can you tell me about them?	Ip
22: A13: They are opposite.	R_{13}
23: A15: Forces in opposite directions and of the same intensity.	R_{15}
25. P: Of the same intensity! Let´s suppose: What is your mass? How many kilograms?	P
26. A8: 70 kg	R_8
27. P: Ok! Let´s add 10 kg more of the cradle, 80 kg. The cradle is about 8 kg. What do you think, will the cradle and him accelerate the same? Will they start at the same speed?	P
28. No! ((All students answer))	R
29. P: Why not? Isn´t it the same Force?	F
30. A5: Because the resistance of one of them is higher.	R_5
31. A4: Because if the Force were constant... then, for example: the mass increased, so the acceleration will decrease to compensate.	R_4
32. P: Right, it makes sense!	A

In round 2, student A4 reports the solution found by her group (zone 5). In the following round, the teacher continues the interaction, aiming at new contributions. Students A16, A15 and A14 interact. The teacher, in turn, accepts the answer of student A14 and summarizes the presented solution. In this segment of the episode (rounds 1-7), initially, the teacher's intention was to create a problem that would make it possible to explore the students' ideas aboutNewton's laws. The content approach was theoretically explanatory and generated *interaction pattern* I, R_4, P, R_{16}, R_{15}, R_{14}, P.

Still in round 7, the teacher performs new initiation. In response, student A14 asks a question in order to solve a doubt. Therefore, from rounds 7 to 10, the teacher's intention was only to keep the narrative. Through interaction pattern I, R_{14}, P, R_{14}, the *content approach* was focused on the theoretical descriptive type.

Taking into account the question of student A14 (round 8), in round 11, the teacher makes new initiation. Student A14 answers. Then, in rounds 13 and 15, the teacher provides feedback so that students can elaborate their answers better. It is important to highlight that the answers given by the students in this segment of the episode (rounds 11-20) represented the Newtonian

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zone (zone 5) and occurred through the following *interaction pattern*: Ie, R14, F, R7, F, R, R14, P, R14, P. At the end of the episode, from rounds 21 to 32, the interactions (confirmed the Newtonian zone (zone 5)) between the teacher and the students led to *interaction pattern* Ip, R13, R15, P, R8, P, R, F, R5, R4, A. The *communicative approach* is, therefore, authority interactive.

That said, the *teacher´s intention* in round 11-32 was to keep the narrative and develop the "scientific story" about Newton's first, second and third laws. Regarding the *content approach*, as of shift 11, it changed from theoretical descriptive to theoretical explanatory until the end of the episode. Chart 8 summarizes all aspects of interest.

Chart 8: Summary of the analysis of teaching episode 2

Rounds and subjects	Profile zone	Content approach	Teacher's intentions	Communicative approach	Interaction patterns
Round 1 - 7	5	Theoretical Explanation	Create a problem. Explore the students' ideas.	I/A	Ip, R_4, P, R_{16}, R_{15}, R_{14}, P
Round 7 - 10	-	Theoretical Description	Keep the narrative	-	Ip, R_{14}, P, R_{14}
Round 11 - 20	5	Theoretical Explanation	Keep the narrative. Develop the "scientific story".	I/A	Ie, R_{14}, F, R_7, F, R, R_{14}, P, R_{14}, P
Round 21 - 32	5	Theoretical Explanation	Keep the narrative. Develop the "scientific story".	I/A	Ip, R_{13}, R_{15}, P, R_8, P, R, F, R_5, R_4, A

With the analysis of the discursive aspects among the subjects in the classroom, it is noticed that episode 1 presented small evolution from zone 3 to zone 5, while in episode 2, there was stabilization of zone 5. It is important to emphasize that, between the meeting in which we highlight the first episode and the one in which we highlight the second episode, the students

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received a text and video lessons which dealt with the subject that would be discussed in the classroom. It is possible that the process initiated by the students at home, individually – a central feature of ALU – prepared the students in such a way that it favored exchange in the classroom which required less active action from the teacher for the construction of the ideas.

In this context, the predominance of the discursive aspect related to the teacher's intention in episode 1, to explore the students' ideas and keep the narrative, is understandable. Once the student-student interaction (rounds 2-15) was able to make them progress in the meanings of their conceptions towards scientifically accepted ones (zone 3 to zone 5). Likewise, in episode 2, it is understandable why the teacher's intention is focused on keeping the narrative for the continuation of the development of the "scientific story", since from the first answer presented to his first initiation, conceptions regarding the Newtonian zone were presented (zone 5). In both episodes, the type of content approach was predominantly theoretical explanatory.

As for the way how the discourse was conducted, there is prevalence of an interactive communicative approach of authority. It is important to emphasize that this type of approach is directly linked to a classroom context, because, although the teacher, through interaction, seeks to see and consider the students' conceptions, he also has the role to guide. In other words, this type of approach is expected, given the need for the teacher to build a “scientific story” and support the construction of the desired scientific knowledge.

Regarding the interaction pattern, the participation of a considerable number of students through a triadic pattern (episode 1), and mainly, non-triadic in open and closed chains (episode 2) is clear. Therefore, we can infer that the methodology collaborated for interaction in the classroom, providing opportunities for the production of individual meanings, by means of the internalization of ideas put together in groups, guided by the teacher in the social context of the classroom.

4.3. Post-test analysis

Chart 9 below shows the emergence of the profile zones in the post-test questions:

Chart 9: Zones of the conceptual profile of strength emerged in the participating students´ answers to the post-test

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Questions	Students							
	A5	A6	A7	A8	A10	A14	A15	A16
1	Z5	Z5	Z4	Z4	Z5	Z5	Z5	Z4
2	Z5	Z5	S.C	Z3 Z4	Z5	Z5	Z5	Z5
3	Z3	Z3	Z2	Z3	Z5	Z5	S.C	S.C
4	Z3	Z5	S.C	Z3	Z5*	Z5	Z3	Z3
5	Z3	S.C	Z3	Z3	Z3	Z3	Z5	Z3
6	Z3	Z3	S.C	S.C	S.C	Z3	Z3	S.C
7	Z5	Z5	Z5*	Z3	Z3	Z5*	Z5	Z3
8	Z5	Z5	Z5*	S.C	Z3	Z5*	Z5	Z3
9	Z3	Z3	Z3	Z3	Z3	Z3	Z5	Z3
10	Z5*	Z3	S.C	Z5*	Z5*	Z5*	Z3	Z5*
11	Z5*	Z3	S.C	Z5*	Z5*	Z5*	Z3	S.C
12	Z5	Z5	Z5	Z5	Z5	Z5	Z5	Z5
13	Z3	Z3	S.C	Z3	Z3	Z3	Z3	Z3*
14	Z5 Z3	Z5 Z3	S.C S.C	Z4 Z3	Z5 Z3	Z5 Z3	Z5 Z5	Z5 Z3

The post-test was applied to 8 students. It shall be pointed out that of the 8 students submitted to the post-test, only 5 (A5, A6, A7, A8 and A10) answered the pre-test as well. Consequently, they will play a prominent role at this point in the analysis, as they are the participants who will enable us to make a comparative analysis (before x after). Therefore,students identified as A14, A15 and A16 answered only the post-test, while students A1, A2, A3, A4, A9, A11, A12 and A13 presented in the previous sections answered only the pre-test.

Thus, similarly to the treatment of the categorization of the pre-test answers, we also present (Figure 3) an overview of the emergence of the zones of the conceptual profile of strength of the participating students referring to the answers to the post-test, through EZP (extension of the profile zone) for each student.

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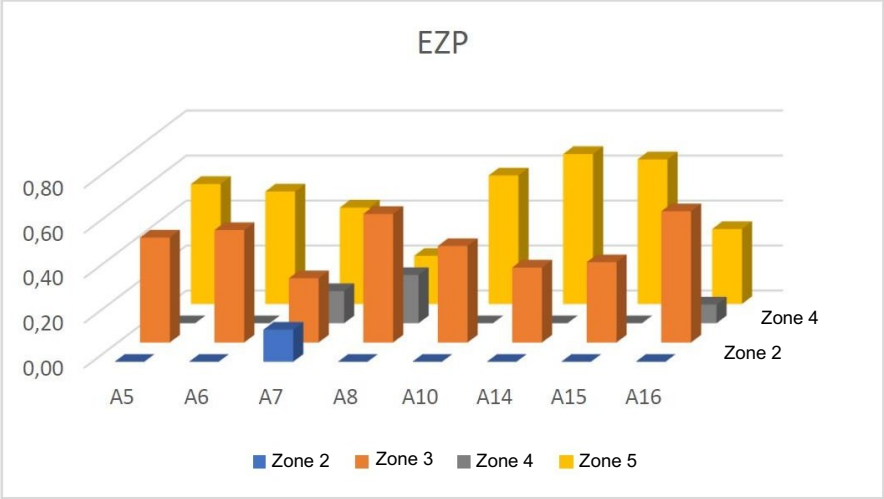

Figure 3: Presentation of the individual conceptual profiles of the students participating in the post-test

Once the information in Figure 3 is explained, it can be observed that the answers provided in the post-test are also located around four zones (Zone 2, Zone 3, Zone 4 and Zone 5). However, when verifying the emerged zones, as well as the extent of the profile zone of the students who took both the pre-test and the post-test, it can be seen that: i) students A5, A7 and A10, who previously exhibited a predominantly pre-scientific, after ALU, had their Newtonian profile intensified; ii) student A6, in turn, before the instruction, presented a predominantly pre- scientific profile; however, after ALU, even expressing better perception of the ideas referring to the Newtonian zone, still presented a prominent pre-scientific profile of the notion of strength; iii) student A8, both before and after ALU, manifested a fully pre-scientific profile.

As for the students who participated in the research, but who took the post-test only (A14, A15 and A16), it should be noted that: i) students A14 and A15 present a greater emergence of ideas referring to the Newtonian zone when compared to the students who took the pre-test. These were also the participants who evidenced pre-scientific ideas the least; ii) student A16, like student A8, expressed prevalence of pre-scientific ideas in his answers.

5. CONCLUSION

In addition to the observation which was possible by means of the pre- and post-tests, the importance of the observation made through discursive analysis is highlighted. By means of such analysis, we were able to bring some details of the discursive dynamics and how the students' conceptual profiles evolve. Thus, it was possible to perceive that making the students aware of their alternative conceptions (exploring the students' ideas) is an indispensable conduct forstudents to become fully aware of the richness of conceptual meanings under construction, and based on that, to be able to select the contextually most effective meaning adequately.

On the other hand, the analysis also showed that, in the classroom context in which the concept profile zone is stabilized around the scientifically accepted (and therefore, desired in the classroom context), ideally, the teacher shall keep attitude of “keep the narrative”. Likewise, our analysis showed that, in order to evolve the profile towards a desired zone, it is convenient to adopt a “theoretical descriptive and explanatory” content approach, whereas, to keep an already stabilized zone, a “theoretical explanatory” content approach is sufficient”.

Regarding the interaction pattern, in order to advance the profile to a desired zone, it is important for the teacher to initiate the process, encourage different answers from the students, and finally, proceed with assessment. On the other hand, to keep a stabilized zone, a more interventionist attitude is required from the teacher, always providing positive feedback.

6. BIBLIOGRAPHIC REFERENCES

Almeida Guimarães, C. R. de., Vieira da Silva, F. C., & Simões Neto, J. E. (2023). Modos de pensar os conceitos de entropia e espontaneidade utilizando situações-problema. *HOLOS*, *1*(39).

Amaral, E. M., & Mortimer, E. F. (2007). Uma metodologia para análise da dinâmica entre zonas de um perfil conceitual no discurso da sala de aula. *A pesquisa em ensino de ciências no Brasil e suas metodologias. Ijuí: Editora Unijuí*, 239-296.

Ausubel, D. P. (1982). *A aprendizagem significativa.* São Paulo: Moraes.

Ausubel, D. P. (2003). *Aquisição e retenção de conhecimentos:* uma perspectiva cognitiva (Vol. 1, pp. p-243). Lisboa.

Bachelard, G. (1940). *La philosophie du non:* Essai d'une philosophie du nouvel esprit scientifique. Paris: PUF.

Bachelard, G. (1978). *A Filosofia do Não*: O novo espírito científico. São Paulo: Abril Cultural

Coelho, M. N. (2019). Unidade de aprendizagem ativa para física: uma possibilidade para a motivação dos discentes. *Revista Brasileira de Ensino de Ciência e*

Tecnologia, *12*(3).

Driver, R. (1989). Students' conceptions and the learning of science. *International journal of science education*, *11*(5), 481-490.

Driver, R., Guesne, E., & Tiberghien, A. (1992). *Ideas científicas en la infancia y la adolescencia* (No. 8). Ediciones Morata.

Fagen, A. P., Crouch, C. H., & Mazur, E. (2002). Peer instruction: Results from a range of classrooms. *The physics teacher*, *40*(4), 206-209.

Freire, P. (1997). Educação "bancária" e educação libertadora. *Introdução à psicologia escolar*, *3*, 61-78.

Gil, A. C. (2017). *Como elaborar projetos de pesquisa*. 6. ed. São Paulo: Atlas.

Halloun, I. (2007). Evaluation of the Impact of the New Physics Curriculum on the Conceptual Profiles of Secondary Students. Phoenix Series, Lebanese University.

Inhelder, B., & Piaget, J. (1955). *De la logique de l'enfant à la logique de l'adolescent.* [From the logic of the child to the logic of the adolescent]. Presses Universitaires de France.

Jammer, M. (1957). *Concepts of force:* A study in the foundations of dynamics. Courier Corporation.

Jorge Benevides, J. de A., Faustino de Sousa, J. L., Ribeiro Moura, L. de Q., Matos Costa, E. L., & de Lima Filho, L. O. (2021). Implementação de metodologias ativas como ferramenta avaliativa na disciplina de fisiologia vegetal em tempos de pandemia: experiências e desafios. *HOLOS*, 4, 1–16.

Malheiro, J. M. S., Diniz, C. W. P. (2008). Aprendizagem baseada em problemas no ensino de ciências: Mudando atitudes de alunos e professores. *Amazônia: Revista de Educação em Ciências e Matemáticas*, *4*, 1-10.

Marconi, M. D. A., & Lakatos, E. M. (2008). *Fundamentos de metodologia científica*. 6. ed. São Paulo: Editora Atlas SA.

Marcuschi, L. (2000). *Análise da conversação.* 5. ed. São Paulo: Editora Ática.

Marques, A. P. A. Z., Message, C. P., Gitahy, R. R. C. & Sousa, S. O. (2018). A experiência da aplicação da metodologia ativa team based learning aliada a tecnologia no processo de ensino e de aprendizagem. *CIET:EnPED.*

Mehan, H. (1979). 'What time is it, Denise?": Asking known information questions in classroom discourse. *Theory into practice*, *18*(4), 285-294.

Mortimer, E. F. (1995). Conceptual change or conceptual profile change? *Science & Education*, *4*, 267-285.

Mortimer, E. F. (2000). *Linguagem e formação de conceitos no ensino de ciências*. UFMG.

Mortimer, E. F., & Scott, P. (2002). Atividade discursiva nas salas de aula de ciências: uma ferramenta sociocultural para analisar e planejar o ensino. *Investigações em ensino de ciências*, *7*(3), 283-306.

Mortimer, E. F., Scott, P. H. (2003). *Meaning making in secondary science classrooms*. Philadelphia: Open University Press.

Piaget, J. (1973). *La formation de la notion de force* (Vol. 29). Presses universitaires de France.

Piaget, J.; Garcia, R. (1983). *Psychogenèse et Histoire des Sciences*, Paris: Flammarion.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: toward a theory of conceptual change. *Science Education* Ed 66: 211–227.

Pozo, J. I., & Crespo, M. Á. G. (2009). *A aprendizagem e o ensino de ciências:* do conhecimento cotidiano ao conhecimento científico.

Radé, T. (2005). *O Conceito de Força na Física:* Evolução histórica e perfil conceitual [Doctoral dissertation, Dissertação de Mestrado. Canoas: Universidade Luterana do Brasil].

Rojas-de-Gracia, M. M., Esteban, A., Bentabol, M. J., Rodríguez-Ruiz, M. D., Bentabol, A., Lopes, A. P., ... & Caña-Palma, R. (2022). Evaluation of implementation of gamification, game-based learning, and active methodologies to the flipped classroom model. In *Online Distance Learning Course Design and Multimedia in E-Learning* (pp. 142-164). IGI Global.

Sousa, M. D. M. de. (2022) *Perfil conceitual de Força:* uma análise das interações discursivas em sala de aula com o uso de Metodologias Ativas. [Dissertação de mestrado, Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte].

Tiberghien, A. (1985). Quelques éléments sur l'evolution de la recherche en didactique de la physique. *Revue française de pédagogie*, 71-86.

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