REVIN
REVISTA INTERNACIONAL DE PESQUISA EM DIDÁTICA DAS CIÊNCIAS E MATEMÁTICA

METACOGNITIVE EXPERIENCES OF HIGH SCHOOL STUDENTS IN PHYSICS LEARNING

EXPERIÊNCIAS METACOGNITIVAS DE ESTUDANTES DO ENSINO MÉDIO NA APRENDIZAGEM DE FÍSICA

EXPERIENCIAS METACOGNITIVAS DE ESTUDIANTES DE LA ESCUELA SECUNDARIA EN EL APRENDIZAJE DE LA FÍSICA

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Abstract: In this article we bring the results of a research that sought to understand how high school students perceived and understood their learning in Physics; if they were aware of what they knew or not, of their facilities and difficulties in the learning process; if they were aware of the strategies they used to learn and when these strategies were efficient or not. The data, analyzed through the ATD, were framed in learning perceptions classified into three types: Totality, Partiality or Non-learning. Seventeen categories emerged for Totality, nine for Partiality and twelve for Non-learning.
Keywords: Metacognition. Metacognitive experiences. High school. Physics learning.

Resumo: Neste artigo trazemos os resultados de uma pesquisa que buscou compreender: de que forma os estudantes do Ensino Médio percebiam e entendiam sua aprendizagem em Física; se eles tinham consciência do que sabiam ou não, de suas facilidades e dificuldades no processo de aprendizagem; se tinham ciência das estratégias que utilizavam para aprender e quando estas estratégias eram eficientes ou não. Os dados, analisados por meio da ATD, foram enquadrados em percepções da aprendizagem classificadas em três tipos: Totalidade, Parcialidade ou Não aprendizagem. Emergiram dezessete categorias para a Totalidade, nove para a Parcialidade e doze para o Não aprendizado.
Palavras-chave: Metacognição. Experiências metacognitivas. Ensino Médio. Aprendizado em Física.

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Resumen: En este artículo, traemos los resultados de una investigación que buscó comprender: cómo los estudiantes de la escuela secundaria percibieron y entendieron su aprendizaje en Física; si eran conscientes de lo que sabían o no, de sus facilidades y dificultades en el proceso de aprendizaje; si eran conscientes de las estrategias que utilizaban para aprender y cuándo estas estrategias eran eficaces o no. Los datos, analizados mediante el ATD, se enmarcaron en percepciones de aprendizaje clasificadas en tres tipos: Totalidad, Parcialidad o No-aprendizaje. Emergieron diecisiete categorías para Totalidad, nueve para Parcialidad y doce para No-aprendizaje.
Palabras clave: Metacognición. Experiencias metacognitivas. Escuela secundaria. Aprendizaje en Física.

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Introduction

Studies to understand the nature of metacognition have been published since the 1970s (FLAVELL, 1971, 1979; FLAVELL; WELLMAN, 1977; BROWN, 1987; NELSON; NARENS, 1994; BOEKAERTS, 1999; SCHRAW; DENNISON, 1994; SCHRAW; MOSHMAN, 1995, SCHRAW, 1998; SCHRAW, 2009; EFKLIDES, 2001, 2002, 2006a, 2006b, 2008, 2009, 2011, 2014; TARRICONE, 2011; FONSECA, 2018; HACKER; DUNLOSKY; GRAESSER, 1998; HARTMAN, 2001; ROSA, 2017). Some concepts have already been consolidated by these authors, among which we highlight three: what metacognition is; understandings of the metacognition construct and the underlying concepts that move and shape learning perspectives; the influences of metacognition for learning in Science, Chemistry, Physics and Mathematics.

In the context of these discussions, research aimed at understanding "metacognitive experiences" became relevant, in a perspective of capturing perceptions of metacognition in the learning process, promoting reflections on how students perceive and trigger their own metacognitive learning process.

In this perspective, the investigation that we developed sought to understand: how High School students perceived and understood their learning in Physics; if they were aware of what they knew or not, of their facilities and difficulties in the learning process; if they were aware of the strategies they used to learn and when these strategies were efficient or not.

To reach this, we started by proposing a data analysis instrument, which signals indication of the perception of the metacognitive experience, elaborated from the study of the metacognition construct by Corrêa *et al.* (2020). To validate the use of the instrument, evidence of the manifestation of metacognitive experience was explored in the sentences elaborated by the students to answer self-evaluative questionnaires about learning in Physics.

To achieve the objectives of this study, whose concluding considerations we describe in this article, a long investigative path was carried out, based on numerous theorists and the results they present, starting with research on learning models and their consequences (CORRÊA *et al*., 2021). This movement allowed us to propose a data analysis instrument that considered research on the elements that make up the domains of the metacognitive system.

In order to clarify this analysis instrument and its application, we structured the article as follows: the description of some details of the methodological procedures; the presentation

of elements of the theoretical bases that led us to the elaboration of the instrument; the emerging categories and their definitions; the mapping of the metacognitive experience presented by the deponents, considering the instrument and the emerging categories.

In the last section of the article, we present the final considerations related to this investigative process, seeking to achieve the outlined objectives and answer the three research questions that we included in the abstract.

Methodological procedures

Before presenting the methodology used in this investigation, it is necessary to clarify that this article presents only part of a qualitative investigation that analyzed data collected over three years, through a script of questions inspired by several authors, which were systematically applied seeking evidence of presence of the metacognitive system in the learning process in Physics. Another important point is the understanding of the data analysis instrument, proposed from the investigation of research already carried out nationally and internationally in the field of metacognition and which can be consulted in Corrêa (2021).

Data collected from seventy-five high school students from a private school in 2018[4], constituted the *corpus*[5] that we expose in this article and the collection and registration of the data were approved by the Ethics Committee (CAAE number: 57663716.9.0000.5231).

The data collection instrument consisted of a set of self-assessment questionnaires, in which students, during the bimonthly assessment processes, established by the school institution, answered a list of questions regarding the learning objectives in Physics, from the completed bimester, specifying the contents/concepts they should have learned. In this questionnaire, they indicated with the letter "T" the items they considered to have fully or totally learned, with the letter "P" the items that they thought they had achieved partial learning and the letter "N" for the items that they could not learn, followed by open questions to justify, explaining what they did to learn totally or partially and also what happened with the topics that they could not learn.

[4] The data are from the year 2018, however there are students, within the seventy-five, who have participated in the survey since the year 2017. When presenting the examples of recorded responses, we will present the codes that help identify these students .

[5] "[...] the set of documents taken into account to be submitted to the analytical procedures" (BARDIN, 2011, p. 126, our translation).

To analyze the justifications presented for the answers given to these questions, Textual Discursive Analysis (TDA) by Moraes and Galiazzi (2011) was used, which expands the possibilities of producing new understandings of the investigated descriptions. The name given to each category arises from the word used or from the approximation of the meaning of the sentence written by the student when explaining what he/she did to learn totally, partially or not to learn the contents/concepts that they should have learned and that appear in the questionnaires.

After these analyses, interweavings were made between these emerging categories and the instrument for mapping the metacognitive system, proposed from theoretical research on the subject and particularized to the metacognitive experiences, seeking to validate the organization and systematization proposed by the instrument. Therefore, it will be necessary to briefly present the path of construction of this instrument and, subsequently, the categories and their conception.

The construction of the analysis instrument: theoretical bases

For this moment, we assume metacognition as a multifaceted and systemic construct[6], connected to the understanding of knowledge of internal and external processes regarding the involvement of cognition and feelings (process of interpretation of emotion), through the domain of self-knowledge and self-regulation processes, encompassing the subject's learning process from his/her experiential contact with the world, with others and with himself/herself.

For a better understanding of this construct it is necessary to distinguish cognitive processes from metacognitive processes, according to Noushad (2008), cognition involves the acquisition and processing of information, dealing with the recall of learning, to assist in the performance of tasks, while metacognition encompasses executive management and strategic knowledge, taking control and guidance of problem solving processes; cognitive skills typically fall within task domains, whereas metacognitive skills span multiple domains.

In the learning process, metacognition is established as a complex network connected due to metacognitive reflection, or what we call a conative metacognitive system, which in essence is a process of immersion in a feeling of total involvement with the activity to be

[6] Construct: object of perception or thought formed by the combination of past and present impressions. In Corrêa (2021) from p. 34, there is a section in which Metacognition is described as a construct.

performed (learning), mobilizing all known structures, consciously or unconsciously, by previous tasks and effecting a reorganization for the efficiency of learning. One might think that "The heart of metacognition is the understanding of the nature of learning and knowing" (FONSECA, 2018, p. 214, our translation).

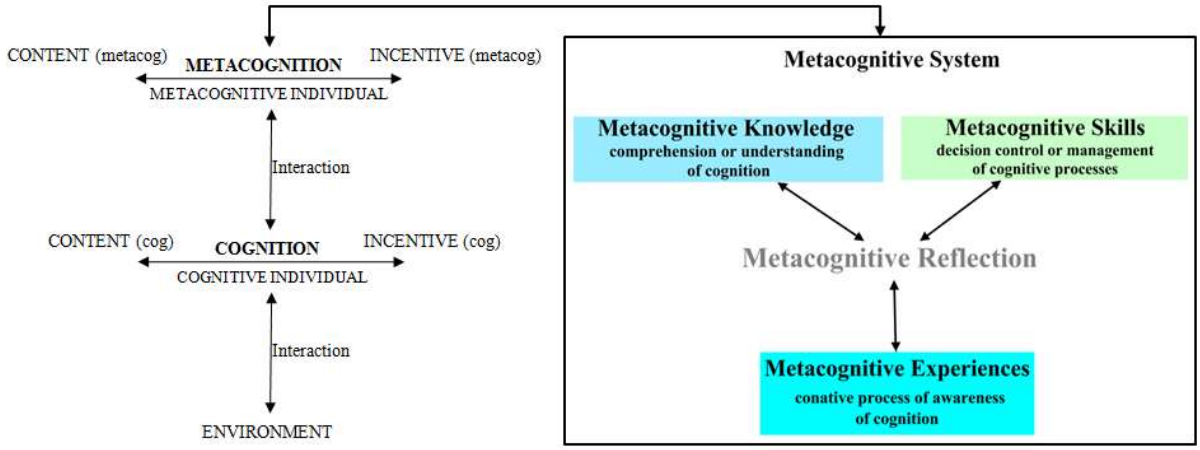
Defining metacognition, as indicated by Tarricone (2011), mainly due to its complexity, is difficult, as it is necessary to consider the multiplicity of influences and connections that constitute it. This fact led to the choice of the representational form to present the connection of cognition to metacognition, which influences the learning process. We emphasize that for this cognitive movement to produce learning, involvement (encouragement) is necessary, as learning is a set of relationships and processes that provoke the individual to perceive himself/herself as a subject under construction.

This cognitive subject only reaches a higher level of understanding and self-knowledge if he/she triggers the reflexive devices of the metacognitive system, which interrelate in a network of intrinsic processes that involve the metacognitive experience, which triggers the metacognitive skills that support the metacognitive knowledge, and this, being constantly reorganized, provides new inferences and reflections to metacognitive experiences, integrating and feeding back in a conscious or unconscious way.

From the understanding of cognition as the ability to process information and transform it into knowledge through experiential interaction with the environment, mobilized by feelings and emotions involved in this context, an advance was made to the learning model of Illeris (2013) in the study by Corrêa *et al.* (2020). Such a metacognitive learning model can be used to understand more complex or difficult learning situations, in which the cognitive process of acquisition and elaboration is destabilized, making it necessary for the subject to be involved with his/her own cognitive process, thus triggering the metacognition through higher-order reflexive processes.

This model was expanded and discussed in the research by Corrêa (2021), in which it was presented through a figure (Figure 1) that connects these fundamental processes of metacognitive learning to domains of the metacognitive system, which encompass metacognitive knowledge, metacognitive skills and metacognitive experiences.

Figure 1 – Representation of the metacognitive system



Source: Corrêa (2021, p. 39, our translation)

In this representation, the metacognitive process is equivalent to the cognitive process proposed by Illeris (2013); in metacognition, the cognitive process (learning) is taken as "external", about which the individual thinks and the environment is now internal to cognition itself. The content (cognitive – cog) and the incentive (cognitive) are the objects or contexts about which the metacognitive subject reflects and elaborates his/her metacognitive learning; the content (metacognitive – metacog) is the metacognitive knowledge, skill and experience; the incentive (metacognitive) can be considered: the complexity of the problem; Dewey's reflective thinking (1933); the conative process; the volition; higher-order reflexive processes, and also satisfaction or dissatisfaction in solving a problem-situation.

The *metacognitive system* presented originates from both Flavell's (1979) and Nelson and Narens' (1994) studies, who define metacognition as a model of cognition that works at a meta level, as well as the multifaceted concept presented by Efklides (2008), in which *metacognitive knowledge*, *metacognitive experiences* and *metacognitive skills* complement each other (CORRÊA *et al.*, 2020).

From this model, it is possible to conclude that the interaction of the cognitive subject, with experiences in the real world, generates learning that can be communicated and participates in the construction of the individual and their socialization, both as a thinking subject and as an active subject in the construction of their universe of knowledge.

However, in the interaction of the metacognitive subject, the experiences are of a higher level, as their environment is now the mind or cognition, which through the interaction of the reflective process, from complex or difficult situations, destabilize the cognitive process of

acquisition and elaboration traditionally used, promoting entry to the metacognitive learning process, also communicated through awareness and expansion of the cognitive process itself, influenced by conation[7], which makes the learning process of the individual as a whole flexible.

The subject, when activating the metacognitive system, performs executive management through improved strategic knowledge, which guides and assists in the control of complex problem solving processes, developing skills that are necessary to understand how the task or problem was performed, spanning multiple domains, even when they have little in common.

Cognitive and metacognitive learning processes occur simultaneously and in an integrated way. These processes belong to different dimensions, involving explicit and implicit knowledge, structural and semantic knowledge, as well as memory interaction in order to facilitate the recall and reconstruction of information and processes, encompassing experiences development, learning and tasks, in addition to involving reflective awareness based on knowledge (known and unknown), strategies, skills and processes.

In Figure 1, the 'map of the metacognitive system' is presented through three sectors, connected by bidirectional arrows to *metacognitive reflection*. These arrows signal a systemic process, in which each sector represents a domain: metacognitive knowledge, metacognitive skill and metacognitive experience; this reflexive process (metacognitive reflection) involves understanding cognition (metacognitive knowledge), with decision control or management of cognitive processes (metacognitive skill), including a conative process of awareness of cognition (metacognitive experience).

Metacognitive reflection, according to Cornoldi (1998), involves beliefs, perceptions and understandings of an activity or a problem, it is influenced by the elements that compose it and its variables. Therefore, metacognitive reflection is essentially the foundation of higher order metacognitive processes and the metacognitive tools themselves are structures that feed back reflection.

The reflection involved here is not a trivial or cognitive reflection, it is a deep and complex process that makes up the self-knowledge and self-regulation of problem solving

[7] Conation: awareness of the process in which the action is carried out (includes impulses, desires and anxieties). Additional descriptions regarding the conative process can be found in Corrêa (2021, p. 33, our translation).

processes, being influenced by feelings, beliefs, false beliefs, prior knowledge, insecurities, assumptions, challenges, capabilities, contexts, knowledge of strategies and processes.

In this 'map' – illustrated on the right side of Figure 1 – there 'metacognitive reflection' in the center as an expression that interconnects the domains of: metacognitive knowledge, metacognitive skill and metacognitive experience, as it is perceived that the structure of metacognition is a reflexive structure that feeds back as metacognitive knowledge is acquired through metacognitive experiences or the application of metacognitive skills; and these, in addition to influencing, are influenced by metacognitive reflection on awareness through metacognitive experience and accumulated metacognitive knowledge. Likewise, metacognitive experiences are reflexive 'states', essentially, that interfere and compose both the domain of metacognitive skills and the acquisition of metacognitive knowledge.

Therefore, the metacognitive system is assumed to be a reflexive network that acts on the cognitive system through the interaction of incentives of diferent natures, such as: reflexive incentives, conative incentives, resolution incentives, feelings of satisfaction or dissatisfaction in solving a problem. Which leads us to consider that metacognition profoundly influences learning processes, because when activated, it mobilizes the entire network of understanding of these higher-order reflexive processes that are available to be applied in other learning contexts or situations.

In the research carried out and whose results we explain in this article, we only describe the connections between the perceptions of the metacognitive system in learning in Physics, particularized for the mapping of metacognitive experiences. Therefore, it is necessary to return to some important concepts for understanding the instrument designed to analyze the data.

Metacognitive experience is initially defined by Flavell (1979) as being long or momentary, with simple or complex contents, with direct influence on metacognitive knowledge, occurring in situations that incite attention and highly conscious thought. Or, situations that provoke or give rise to 'thoughts about one's own thoughts', impressions or cognitive or affective conscious perceptions.

However, Anastasia Efklides presents, from 1980 onwards, a study in which the metacognitive experience is not exactly the emotion or the affect, but is directly related to judgments, feelings and reactions that occur during a cognitive task or complex problem solving. A fact that reminds us of the manifestations of conative monitoring of cognition, when

the individual is faced with a cognitive task and intentionally processes the information related to it, it is a kind of sense or perception that allows us to understand aspects of cognition, an online monitoring (EFKLIDES, 2001, 2002, 2006a, 2006b, 2008, 2009, 2011, 2014).

Efklides (2006a) states that, in essence, metacognitive experiences make the individual aware of the fluency or interruption of cognitive processing and the correspondence or incompatibility between the set of goals and the result to be achieved, providing information about the individual's ability to execute given task and achieve the expected result. According to Efklides (2001), metacognitive experiences are influenced by the following variables: person, such as cognitive skill, personality and self-concept; *task*, complexity, performance, and previous experiences with similar or related tasks; *strategy*, such as strategic metacognitive knowledge.

These experiences take the form of metacognitive feelings, metacognitive estimates or judgments, and task-specific knowledge (EFKLIDES, 2001, 2008). Metacognitive feelings, like all other aspects of metacognition, convey information about cognition with an affective character, and this association of feelings that are non-analytical in nature, having positive or negative valence, is supported by neuropsychological evidence that locates metacognitive monitoring in the anterior cingulate cortex, an area connected to both affective and cognitive regulation (FERNANDES-DUQUE; BAIRD; POSNER, 2000).

The presence of feelings implies the personal character of the metacognitive experience, a sensation that occurs during a cognitive effort, it is the personal and subjective experience itself, very close to real cognitive processing, with self-judgment and self-reactions, based on information available in short-term memory. They are all products of the person's interaction with the task. According to Efklides (2001), it is the mind's ability to know and integrate information about itself and experiences (past/present), to control or direct present or future behavior.

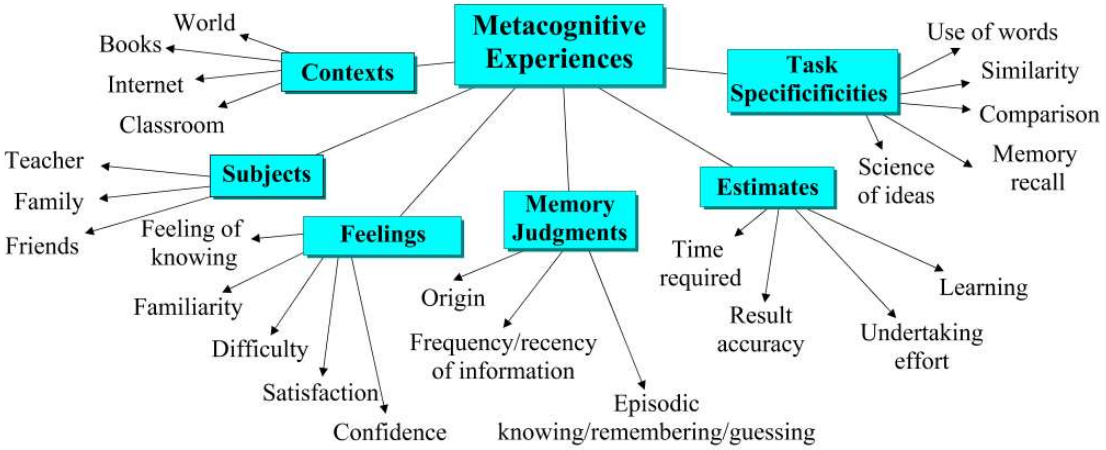
Efklides (2009), when referring to the role of metacognitive experiences in the learning process, provides some clarification on: metacognitive feelings (feeling of knowing, feeling of familiarity, feeling of difficulty, feeling of confidence and feeling of satisfaction); metacognitive judgments or estimates (learning estimation, effort estimation, time estimation, and outcome accuracy estimation); memory judgment (origin of episodic memory, which

relates the uncertainty of knowing/remembering/guessing and frequency or recency[8] of information); and task specificities (use of words, similarity, comparison, memory recall and science of ideas).

In the representation of Figure 2, in addition to what we exposed in the previous comments, we add: subjects (teacher, family, friends) and contexts (world, classroom, internet, books), based on the research carried out by Corrêa, Passos and Arruda (2018a, 2018b).

By understanding that forms of awareness are manifestations of how people understand the awareness of the learning process, that is, the metacognitive process of learning, we intend to use the 'map of the metacognitive system' (Figure 1), particularized to the 'mapping of metacognitive experience' (Figure 2), as an instrument for categorizing the metacognitive experience, to analyze the responses students manifested when explaining their perceptions of the learning process in Physics.

Figure 2 – Instrument for mapping the metacognitive experience



Source: adapted from Corrêa *et al.* (2020, p. 130, our translation)

For Efklides (2009), each of the forms of awareness of the metacognitive experience is considered a manifestation of how the person is faced with a task and processes the information related to it. These manifestations of metacognitive experiences will be briefly explained in the paragraphs that follow.

[8] Recency: state or quality of what is recent; situation in which the last information received about something or someone is most likely to be remembered. We assume recency, in the same way as Efklides (2009). Several information about the category 'memory judgment', which incorporates recency, can be accessed in Corrêa (2021, p. 49).

The *context* refers to the circumstance that accompanies the fact or situation that caused awareness, such as some occurrence prompted by the reflective process generated by reading a book, a text, watching an internet video, or even an occurrence in the classroom, which can be the performance of a school task or assessment which, according to Corrêa, Passos and Arruda (2018a, 2018b), are situations caused by interactions with the world (objects and places), which serve as cognitive objects that can trigger the metacognitive process through the metacognitive experience.

The *subject* referenced here in the relationship with others (CORRÊA; PASSOS; ARRUDA, 2018a, 2018b) brings the personal variable (intrapersonal) or the realization of cognitive comparisons in social relationships (interpersonal), which can incite the occurrence of metacognitive awareness , when relating, as in the case of solving a complex situation with teachers, family or friends. These subjects function as cognitive objects in the metacognitive process of acquisition and elaboration of strategies or personal declarative metacognitive knowledge, activated through reflexive processes integrated to metacognitive experiences.

Metacognitive *feelings*, according to Efklides (2009), have a hedonic characteristic, which means that they have access to both cognitive and affective regulatory circuits. These feelings may involve: feeling of knowing, which is related to the tip of the tongue phenomenon; feeling of familiarity, which considers that the stimulus has already occurred and immediately links it to processing fluency, which is a kind of accessibility to information; feeling of difficulty, which is linked to the conflict or lack of resolution in processing; feeling of satisfaction, which monitors whether the solution meets the person's standards; feeling of confidence, which monitors whether the person was fluent or had interruptions in the way they reached the solution (TARRICONE, 2011).

Estimates or *metacognitive judgments*, according to Efklides (2009), can be a product of the unconscious and consciously inform the selection, application and control of strategies. They are: learning estimates, involving feeling and knowing phenomena; result accuracy, influenced by the belief in cognitive ability, self-concept and self-efficacy; and, effort undertaking and time required that are influenced by the complexity and demands of the task.

Memory judgments are judgments about what the subject understands as memory characteristics in universal, intrapersonal and interpersonal terms, such as: memory origin, memory accuracy, which facilitate allocation to a context; episodic memory judgments, which

refers to the feeling of knowing, remembering, or guessing; frequency or recency of information, related to metamemory monitoring. These judgments depend on reflective assessment and are influenced by the personal metacognitive characteristics mentioned above (TARRICONE, 2011).

Task specificities refer to specific characteristics for the resolution of an activity or task, and are related to the use of words referring to the task objectives, similarity and comparison in the resolution process, need of the memory recall of some specific concept or formula; or science of ideas, referring to the context of analyzed or processed knowledge.

Efklides (2001) states that, essentially, metacognitive experiences monitor the interaction between variables: person, task and strategy; but they are also products of these interactions, that is, the experience feeds metacognitive knowledge and skills, being fed back when interacting in this conative process, as a kind of reflexive awareness, in which the reflexive movement between knowledge, skill and metacognitive experience interacts harmonically.

In summary, the metacognitive experience occurs when the individual is faced with a manifestation that a learning process has failed or is not flowing properly. This manifestation is necessary to start the strategy regulation process, that is, to trigger the metacognitive ability, and to put it into action it is necessary to resort to metacognitive knowledge. This metacognitive process happens through reflexivity in mental processes (cognitive and affective).

Highlighting the advances in discussions about metacognition in the learning process for the domain of the metacognitive experience, with the use of the metacognitive experience mapping instrument for data analysis about learning, with the intention of signaling the indications of the manifestations of the metacognitive experience, we will present the application of this instrument next.

Emerging categories: initial analyzes

First, we present the emerging categories from the analysis of students' answers to learning perceptions, based on Textual Discursive Analysis (TDA), seeking to characterize the metacognitive experience of these perceptions, and then we present an interweaving of these categories to the proposed instrument, seeking its validation through the relationships found.

To arrive at these categories, which we will describe below, it was necessary to fragment the students' answers, so that the meanings could be reached in full and in depth, considering both the sequential criterion of use of the meaning and the importance given through the adjective, thus understanding that the number of records per category is variable and was used in this way, with the objective of broadening the understanding of what was exposed by the students and, therefore, constituting the criteria for the disclosure and creation of the categories.

It is also important to point out that, in this investigative movement, we consider that perceptions are impressions or mental organizations (observation, recognition, judgment based on individually relevant aspects), which occur by memory processes that involve, in addition to cognitive memory, affective memory, these may interfere in the interpretations of learning situations that occurred or not during the self-assessment.

In Tables 1, 2 and 3, the categories (see column 1) that emerged from the answers analyzed from the justifications described when answering about the perception of Totality (Table 1), Partiality (Table 2) or No Learning (Table 3) are presented. In the second column, we inserted two examples[9] of excerpts related to the category, when describable[10], and in the third column the number of excerpts allocated to the category.

Table 1 – Emerging categories for Totality and their frequency of manifestations

Categories	Examples	Total
friends	I tried to understand other ways, I asked someone for help[11] who didn't have any difficulty. (102E18[12]) With assistance from someone. (93E18)	8
notes	I took notes. (4E17[13]); Reading the textbook and making drafts. (108E18)	18

[9] We opted for the presentation of two examples, as the insertion of a greater amount or the entirety of the examples would make the article too long. However, we reaffirm that the completeness of this information can be accessed in Corrêa (2021).

[10] Note that in the 'nothing' and 'no answer' categories, we cannot insert examples.

[11] Underlined sections are prominent indicators of the word, expression or phrase used to aid in the allocation of a given category. These indicators were used throughout the entire research.

[12] 102E18 – We inform that the codes inserted after the examples were constituted as follows: the initial numbering indicates the number that represents the student, in this case student 102; the letter E indicates the school the student attended, as the data were collected in two schools, but for this article we only bring statements from school E; then, the number 18 represents that the student was part of the 1st year of high school in 2018, so 1 and 8.

[13] 4E17 – Indicates student number 4, who was in the 1st year of high school in 2017. 4 – student number; E – school; 1 – 1st year; 7 – in the year 2017. However, the data used for interpretation are the data from the year 2018. We also emphasize that we collected data for three consecutive years: 2017, 2018, 2019. Which means that we have students who participated in the survey for three years, that is, throughout all of High School.

attention in class	In the classroom I tried to pay as much attention and apply as much concentration as possible. (8E17) I paid attention in class. (104E18)	80
understanding	I managed to have a greater understanding. (51E27[14]) The ones I indicated with a T were the ones I most understood during my studies. (46E27)	23
concept already learned	What really helped me was that I already had a sense of these topics from other years I studied. (45E27) These subjects are not so theoretical, which I had already studied in the 9th grade. (81E18)	12
confidence	Because I'm good at this part of the concepts. (93E18) In the alternatives I marked T, these were the activities I knew how to do. (30E17)	4
dedication	I put in more effort than I did in the other themes. (34E27) I dedicated myself more. (32E27)	40
facility	These were the subjects that I had the most facility. (3E17) It was easier for me to learn. (51E27)	36
interest	I learned because they were the subjects that I was most interested in and focused on the most, I gave them more. (49E27) I paid attention in class and liked the subject. (27E17)	19
internet	I saw video classes on the internet. (79E18) I searched about it on the internet. (80E18)	28
reading	I read the textbook a lot. (87E18) I read it many times. (37E27)	41
memory	Quick and short memory about the content. (53E27) I just know that I remember everything. (27E17)	9
nothing	Did not mark any T.	34
no answer	Left blank.	39
relate	It was because I applied the concepts in my daily life. (25E17) Linking the knowledge I already had with those presented in class. (10E17)	11
summary	I learned while I was making the summary. (16E17) Making the summary. (24E17)	32
homework	I was able to do the exercises at home. (94E18) I did a lot of exercises. (97E18)	77

Source: the authors

The justifications, to explain what was done to achieve the totality of learning of certain concepts, were analyzed through TDA, from which seventeen categories emerged: friends, notes, attention in class, understanding, concept already learned, confidence, dedication,

[14] 51E27 – Indicates student number 51, who was in the 2nd year of high school in 2017, hence 2 and 7 in the code.

facility, interest, internet, reading, memory, nothing, no answer, relate, summary and homework.

For the "friends" category, it was understood that learning was justified with direct mentions to colleagues – an explanation from a friend, or indirect ones – asking someone for help; for "notes", the words used by the students when they answered directly: I took notes, as well as for other representations with the same meaning – drawings, sketches, diagrams; for "attention in the classroom", associated with the expression attention in the classroom, itself; for "understanding", they encompassed both the mentions of the word comprehension and also understanding or absorption of content; for "concept already learned" were the mentions of contents learned in previous years; for "confidence", both the word confidence itself and the words I know, I learned and I am good at were observed; for "dedication", the attributions of the word dedication as through the words effort, I studied and I reviewed; for "facility", the word "ease" and or "facility" and its variations: easy and easily; for "interest", the word interest or expressions such as: what I liked the most or identified with; for "internet", mentions about research carried out on the internet or videos; for "reading", the use of the words read and reading; for "memory", the words remember, remembering, mentally and the word memory itself; for "nothing", the absence of registration; for "no answer", the questions left blank; to "relate", the use of the words related, applied, linking, associating and connecting; for "summary", the word summary itself; and for "homework", mentions of homework and exercises.

It is possible to state that the students addressed cognitive aspects as in the sentences: (83E18) "Basically, it was through reading and doing the summary"; (89E18) "Studying the formulas: explaining something, in my mind, doing exercises, reading more about the book, drawing"; (39E27) "I paid attention to the classes, I remembered the content of the 1st year, I did my homework and reviewed the content through the summaries". Recognition of the cognitive aspects of learning can be understood as an initial step for the metacognitive learning process, in which awareness of the cognitive process itself occurs for possible expansion.

However, it is also possible to signal indication of metacognitive aspects, as in the sentences of (4E17) and (9E17), respectively: "I related the content with my daily life, answered questions and did the proposed exercises".

> First, in the classroom I tried to pay as much attention and apply as much concentration as possible. Always writing down concepts and observations, asking questions when necessary. And the main thing was doing exercises, doing the homework daily, consulting the formulas and relating them. (9E17)

The metacognitive aspects referenced here concern the understanding of strategies and planning/recognition of actions to identify the strategy developed for learning, which go beyond cognition through a reflection on the cognitive process, understood as metacognitive reflection.

The evidence that the students somehow performed a metacognitive reflection can also be exemplified by the phrases: (30E17) "In the alternatives I marked T, these were the activities I knew how to do, I also knew how to do them, as it was one of the classes that most caught my attention, so I was able to understand more about these issues"; (47E27) "The questions that I indicated T, I used the easiest method for me, which would be the reading and elaboration of the summary with the formulas. These options are more theoretical and do not envolve so many calculations, which makes it easier for me"; (45E27) "Kepler's first and second Law I learned better because I went to Astronomy classes last year. The other questions I had already learned in the second year and so only a little attention was required"; (20E17) "I studied, did exercises, watched video classes, and related to the content"; because in these sentences, signs of self-knowledge necessary for metacognitive reflection are presented, even if they are discreet.

This metacognitive reflection possibly involved aspects of self-knowledge, for example, in the categories "facility", "dedication", "interest" and "memory", in addition to being influenced by feelings, as described by the categories "confidence" and "interest", and others that are intrinsically related, such as the "friends" category, which involves social factors of metacognition; and recognition of: cognitive skills (specific to a given content), for example, in the categories "reading", "homework", "internet", "notes" and "summary"; and metacognitive skills (necessary to understand how the task was performed), as in the categories "relate", "concepts already learned" and "understanding"; the categories "attention in class" and "dedication" are indications of the occurrence of metacognitive monitoring.

Next, in Table 2, we organize, as in the previous table, the categories emerging from the justifications regarding the partiality of learning certain concepts. The categories that emerged were: complexity, inattention in class, ignorance of the equations, difficulty, doubts, lack of memory, no answer, little dedication and superficiality.

Table 2 – Emerging categories for Partiality and their frequency of manifestations

Categories	Examples	Total
complexity	I found it too complex. (89E18) Because they involve multiple concepts. (47E27)	17
inattention in class	I didn't fully learn due to lack of attention to class. (94E18) I ended up not paying much attention in class. (42E27)	37
ignorance of the equations	I didn't mark T in questions talking about equations, because I don't do well with equations. (83E18) Because sometimes I understand, but when I do an exercise I can't. (99E18)	28
difficulty	because I can't learn physics. (80E18) I studied, but when it came time to do the tasks I had difficulty. (38E27)	50
doubts	They were average, I needed to read at home to understand, but I still mess up. (14E17) I had doubts and was ashamed/afraid to ask. (106E18)	15
lack of memory	I only remember a few things about the concepts. (92E18) Because I don't remember very well how it works. (35E27)	16
no answer	Left blank.	24
little dedication	Maybe I didn't study enough to learn. (80E18) The partials are those that I know little about, besides, I didn't try as hard as I should have. (85E18)	82
superficiality	Well, I read it, but I didn't fully understand it. (90E18) I feel the subjects went by too fast and too superficially, which leaves me with the feeling that I didn't learn. (46E27)	43

Source: the authors

For the "complexity" category, the interviewees used the words complex, complicated or multiple concepts; for "inattention", the answers that involved having little attention, losing part of the explanation, being distracted, not being able to follow the explanation or not paying attention were used; for "ignorance of the equations" we have sentences about not knowing how to use formulas, not knowing the formulas, knowing the content, but not knowing how to solve exercises, or even not knowing the mathematical aspects; for "difficulty", we selected the answers that described the word difficulty itself, such as difficult, I can't, I didn't understand, impossible to learn or answers that claimed that they had done everything and even then couldn't learn; for "doubts", the mentions of doubt, confusion or the fact of getting mixed up with concepts; for "lack of memory", the denominations lack of memory, not remembering and forgetting; for "no answer", the questions were left blank; for "little dedication", the very lack of dedication, little effort, little study or lack of commitment; for "superficiality", the answers that involved the lack of completeness of understanding.

The category "little dedication" was strongly mentioned, indicating that most students understand that dedication is a benchmark for learning to be accomplished, a category that is justified when checking the categories regarding “superficiality”, “difficulty” and “inattention in class”, which indicate the need for greater dedication; the “complexity” category involved concepts of generalized difficulty by the content or by the discipline of Physics, as well as (88E18) explains:

> These issues are complicated for me, I can’t solve them, because in Physics each exercise requires us to develop a unique thought, apply formulas and this ends up being very difficult and complicated, it has to take into account many things, small details.

While the “difficulty” was attributed to personal narratives, such as (102E18) “I can’t explain, most of the time I just start, but I can’t finish” or (89E18) “I can't learn, no matter how hard I try, it doesn't stay in my head”.

The category “superficiality” was mentioned as a word to justify the lack of totality of learning some contents, as in the sentence: (46E27) “I studied a lot about these subjects too, but I ended up not being able to fully understand the subject”; the “doubts” indicating confusion with the concepts, as in the sentence: (104E18) “I understood while I explained, but when it came time to solve it, I was confused”, or, still, (9E17) “Some parts I did not understand correctly and I had doubts” ; the “ignorance of the equations” was addressed by indicating the existence of content learning, but not the application of equations or solving exercises, while the “lack of memory” was attributed to the concepts that they believed to have learned, but at the time in which they were asked, they did not remember, such as (49E27) “I remember the story, but not with the amount of detail and information necessary”, and also “These are stories that I remember, but for some reason they are not clear in the my mind” from the same student, however, at different times in the year 2018.

Difficulties, lack of attention to classroom explanations and doubts ended up influencing both memory and dedication to studying. It is possible to signal evidence that the students realized why they were not able to achieve the totality of learning in Physics, as they consider - Physics - a complex subject, and were unable to dedicate themselves to achieving the totality of learning.

With this analysis, it is possible to notice the interference of objective factors, but the subjective factors to the students predominated the justifications. This makes it possible to infer

indications that go beyond the cognitive aspects of learning, signaling a metacognitive reflection, involving the metacognitive experience provided by the need to justify why they were not able to fully learn certain contents.

Evidence can be observed that the questionnaire performed the role of a metacognitive incentive, possibly activating the metacognitive system, through metacognitive reflection, which involves beliefs, perceptions and understandings about oneself, signaled by the categories "little dedication", "doubts" and "difficulty", exemplified by the phrases: (32E27) "I lacked a little more will, effort, and solving more exercises"; (235E17) "I only learned a little, but I still have doubts, but I'm ashamed to ask and then I don't understand everything"; (92E18) "I didn't get to do the homework on time, I didn't make an effort to understand what I didn't understand"; (87E18) "Maybe at the first moment, in my opinion, I had completely understood it, but at the time of performing the exercises I had difficulty".

It seems evident to us that metacognitive reflection is connected to the characteristic elements of metacognitive knowledge, with regard to the understanding of cognitive processes, as indicated by the categories: "inattention"; "ignorance of the equations"; "complexity" and "difficulty"; exemplified by the phrases: (86E18) "Because I lacked a little more attention in class, I needed to get the content a little more, so I didn't fully learn"; (88E18) "The reason I didn't fully understand these issues is that at the time of the calculations I didn't know how to do them"; (47E27) "Because they involve multiple concepts in addition to involving equations"; (88E18) "I couldn't fully understand why, depending on the questions, everything seems to change, and there are many formulas to use and memorize. Sometimes the subject is not very complex, but as we only spend a short time on it, it becomes difficult".

All these findings lead us to infer that metacognitive reflection, possibly connected to metacognitive knowledge, may have mobilized the metacognitive experience as a whole, providing a possible awareness of the attitudes and feelings that involved the learning process in Physics, such as those presented in the lines: (98E18) "When I studied, I thought I knew everything, but now I'm starting to find it difficult to do exercises about it and that's why I scored P"; (22E17) "I couldn't fully learn, because I didn't study the subject anymore, and I only learned a little, because I remember some things from the class"; (39E27) "Even paying attention and doing the tasks, I could not understand in a practical way such contents and ended up leaving them aside when reviewing the subject".

The categories that emerged from the explanations about what happened in the questions that the students indicated "N", stating that they had not learned certain concepts, were: calculus, complexity, inattention, disinterest, difficulty, doubts, absence, lack of memory, incomprehension, nothing, no answer, little dedication.

Table 3 – Emerging categories for No learning and their frequency of manifestations

Categories	Examples	Total
absence	The main reasons for not paying attention, and being late for class, or even missing class due to tardiness. (85E18) Not worrying, and because I missed a week. (86E18)	12
calculus	These are subjects that involve Mathematics more. (47E27) That's why, even though I tried hard to find out which formula to use in the question, I couldn't understand it. I even searched for several exercises on the internet, mainly for college entrance exams. (18E17)	35
complexity	I didn't understand the concepts or the explanation and they are more complex matters. (26E18) I found the subject more complicated and I couldn't learn it right. (80E18)	11
inattention	I was dispersed, I didn't look at the board at the formula notes nor did I care and I just did the homework. (15E18) I didn't understand it because I didn't pay attention and didn't go back to retrieve the lost content. (22E17)	60
disinterest	It was content that I was not understanding, as I was not motivated, interested in the subject. (85E18) These are subjects that didn't interest me, so I let it go. (38E27)	15
difficulty	I can't understand or do the exercises alone. (88E18) I found it very difficult, I can't do it. (14E17)	61
doubts	I didn't do the exercises or ask questions. (94E18) I didn't understand nor did I have the courage to show the teacher any of my doubts. (4E17)	17
lack of memory	These are subjects which I don't remember, [...]. (81E18) I couldn't understand it very well, and even though I studied all this, I don't remember. (98E18)	28
incomprehension	I didn't understand and it was also a lack of resuming the subject. (89E18) I remember these materials in the textbook, but I don't know what they mean or how to apply them in an exercise, maybe because I might have been inattentive during the explanation and I didn't try to learn them better. (39E27)	69
nothing	Absence of registration.	14
no answer	blank questions.	46

little dedication	I didn't study as I should. (41E27) I didn't pay attention in class, I didn't study at home, I didn't read the textbook and I didn't even try to know how to do it. (24E17)	100

Source: the authors

As in the previous cases, we used the words and/or expressions used by students to create the categories. In the continuation of the paragraph we elaborate some clarifications. For "calculus" the words that related to the calculation itself were listed, but also formulas, solving exercises, graphs and calculations; for "complexity" it was understood the use of the word complexity itself, as well as complex or complicated; for "inattention", the expressions and/or words lack of attention, being dispersed, distracted, important content going unnoticed and not paying enough attention; for "disinterest", the lack of interest, the fact of not liking or not identifying with the content; for "difficulty", the use of the word difficult or difficulty itself, as well as the fact of not being able to do something, not knowing and not learning; for "doubts", the word doubt itself, as well as confused, to be lost or not to ask; for "absence", the justifications for being absent from class, missing class; for "incomprehension", mentions of lack of understanding or not knowing the meaning; for "nothing", the absence of registration; for "no answer", the questions were left blank; for "little dedication", the expressions: lack of dedication, lack of studying or doing homework/activities/exercises, and also justifications emphasizing what they had not done or should have done.

It is clear that "little dedication" is the most indicated perception by students, followed by: "incomprehension", "difficulty", "inattention" and "no answer". It is clear that "little dedication" was significantly perceived and mentioned, which demonstrates that students linked no learning, mainly, to lack of involvement with studies, not restricting no learning to approaches related only to content.

In the analysis of no learning, it can be understood that students are aware of what happened to explain why these contents were not learned, as they indicated this fact through justifications: (48E27) "I didn't study in depth, I just took a look"; (94E18) "The questions in N are due to lack of attention, and sometimes from not doing classroom and home exercises or reviewing the material at home, also when I have huge doubts, but I feel kind of awkward in asking questions"; (3E17) "These were subjects that I didn't understand very well from the beginning and I didn't try to understand better"; (26E17) "These were questions I didn't study outside of class".

Such reports bring evidence of metacognitive reflections, because when confronted with no learning (cognitive ability: identify whether or not learned through Q1A[15]), the students knew how to argument clearly about their learning or no learning process (perception of the metacognitive process through the Q1B[16]) and they demonstrated to know the moment or situation in which this process was interrupted.

The justifications presented in the excerpts that follow portray what we highlighted in the previous paragraph: (80E18) "Because I don't like physics, I created a mental block in my brain, and I can't learn"; (3E17) "These were subjects that I didn't relate with and I had a lot of difficulty, leaving these subjects a little aside instead of putting them as a priority" or, "These were subjects that I mostly missed in classes and didn't go in depth to be able to understand"; (81E18) "These are subjects I don't remember, due to lack of attention in class and being afraid to ask my doubts, and also because I can't memorize it"; (2E17) "It was more laziness, because if I studied a little more I would have understood it";

> Initially, I thought they were easy questions, but I had great difficulties. These are relatively simple matters, but in their application in exercises, for example, there were great doubts. I also missed a class that made a huge difference in learning. (87E18)

It was possible to see evidence that the questionnaires acted as a metacognitive incentive, which possibly triggered metacognitive reflection through self-knowledge to solve problems, remembering that this is influenced by: self-awareness of cognition, self-assessment of cognition, self-discovery (strengths and/or weaknesses), cognitive characteristics and attributes of the person, beliefs about oneself, prior knowledge, assumptions, etc.

Such signs of the occurrence of metacognitive reflection are pointed out, for example, by the categories "inattention" and "difficulty", detailed in the sentences: (103E18) "I can't focus enough because I know it's something I won't be able to do, and I can't even look for other means"; (19E17) "My difficulties with problems (exercises) are many. That's why, even though I tried hard to find out which formula to use in the question, I couldn't understand it. I even searched for several exercises on the internet, mainly for college entrance exams";

[15] Questionnaire 1 – Self-Assessment: which was applied every school quarter of the year 2018 and which aimed to carry out a metacognitive assessment of the contents/concepts (CORRÊA, 2021).
[16] Questionnaire 1 – Self-Assessment: which was applied every school quarter of the year 2018 and which aimed to collect the justifications presented for the choices made in Q1A (CORRÊA, 2021).

(101E18) "I spaced out from the classes", understanding that these are just a few examples, and all categories have phrases that signal indications of metacognitive reflection.

We also detected fragments that registered the metacognitive experience, which corresponds to the manifestations incited during online metacognitive monitoring, as in the case of the categories "difficulty" and "disinterest". The following sentences exemplify what we say: (23E17) "I have difficulty doing math"; (3E17) "These were issues that I did not identify with and I had a lot of difficulty, leaving these issues aside instead of putting them as a priority"; (30E17) "In these questions I scored N, because they didn't draw my attention that much, so I couldn't pay much attention in class". It should be noted that these phrases are not the only ones that point to signs of metacognitive experience, that is, in practically all categories we find them.

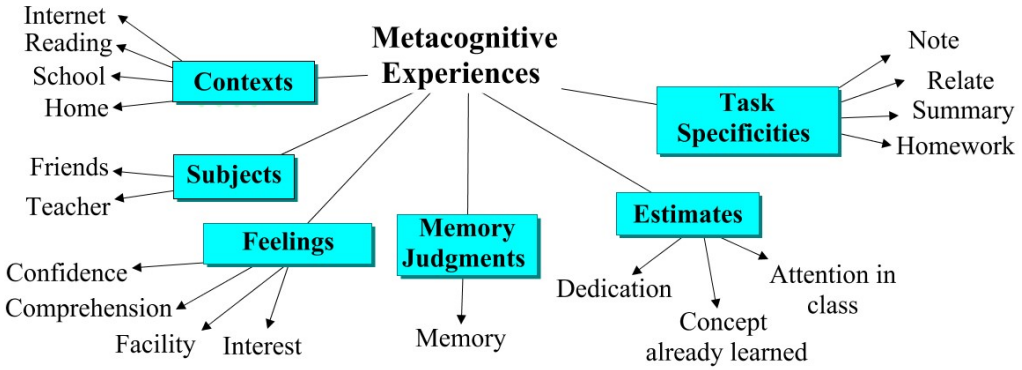
Next, will be presented what we call 'intertwining' of the emerging categories (present in column 1 of Tables 1, 2 and 3) from the analysis of the students' justifications when answering the self-assessment questionnaires on learning in Physics, with the domain elements, with the elements of the metacognitive experience domain proposed by the metacognitive experience mapping instrument (Figure 2).

Application of the metacognitive experience mapping instrument

In this section we have three figures – 3, 4 and 5 – that represent the metacognitive experiences related to Totality, Partiality and No Learning of Physics concepts of the researched students.

It is worth recalling that for this triple elaboration, we assume that the perceptions described by the students and organized in emerging categories, approach what is understood by the manifestations of the metacognitive experience, which involve feelings, judgments, reactions influenced by personal beliefs about learning, difficulties, contexts, effort undertaking and previous experiences and we integrated the seventeen categories (Figure 3), nine categories (Figure 4) and twelve categories (Figure 5) to the analysis instrument for the mapping of the Metacognitive Experience (Figure 2).

Figure 3 – Metacognitive experience for the Totality of learning in Physics



Source: the authors

In recognizing the actions or manifestations that led to the perception of the totality of learning of certain concepts/contents of Physics, it is possible to carry out the mapping with the categories found, approaching some meanings and excluding only the categories “nothing” and “no response”, since they are not part of the perceptions, due to the absence of them. This will also be considered in the next mappings and in the elaboration of the interpretation carried out.

In order to read this mapping explained in Figure 3, as well as the others that will follow, we chose to consider the elements that received the most manifestations in descending order.

For *Task Specificities*, with 138 mentions, approximations to the original definitions were made, the categories that involved relating concepts were understood here as part of the original comparison category; we understand taking notes and summaries as belonging to the original word use category; and doing homework was understood as the original category of Science of ideas.

By pointing out the attention in the explanations in class and dedication, it is understood that the effort is undertaken; while the recognition of having already learned a certain concept to learning for *Estimates*, with 132 recurrences.

For the *Feelings* (91 statements) the following were identified: confidence; interest; facility understood as recognition of the lack of difficulty, as the word used in the source map was difficulty; and comprehension assumed as a feeling of knowing.

While the *Contexts* (69 references) were addressed in the references of videos or internet searches, reading a textbook that is part of the teaching material used by the school, but which was registered as a time of study at home, signaling the relevance of the contexts, therefore, school and home were inserted as implicit contexts.

The *Memory Judgment* was mentioned 9 times when recognizing memory as being an important piece for the identification of learning.

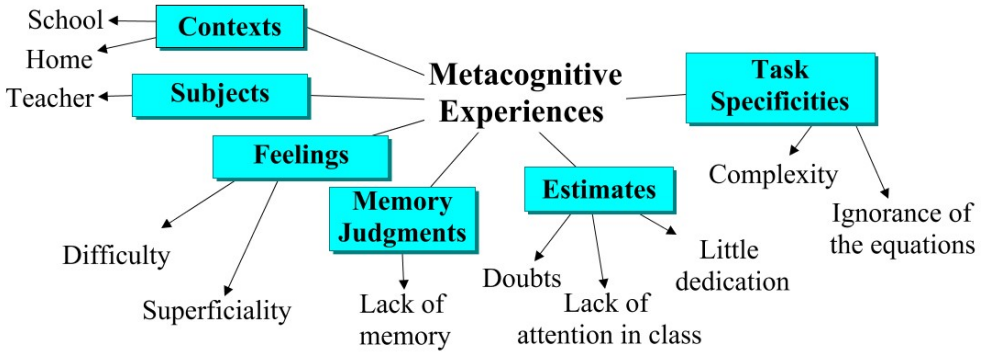
In addition to the presence of the friend when learning, we also include the teacher who is implicit in the attention in the class, represented by the *Subject* category.

Safeguarding the necessary approximations, it is possible to find similarities between the elements of the domain of metacognitive experience and the categories emerging from the analysis of sentences written by students to justify the totality of learning the concepts/contents of Physics.

The analysis of the justifications for the "P" indications allowed the construction of the mapping of metacognitive experiences for the perception of partiality in the learning of certain concepts/contents in Physics, bringing some meanings closer and excluding only the categories "nothing" and "no answer" that are not part of the perceptions, but rather the absence of them.

Figure 4 presents the mapping of the metacognitive experience for the analysis carried out from the categories emerging from the sentences regarding the partiality of learning Physics concepts.

Figure 4 – Metacognitive experience in the Partiality of learning in Physics



Source: the authors

For *Estimates*, with 144 recurrences, attention and dedication were approached as inattention and little dedication, together with doubts, assumed as lack of accuracy of the result.

While the *Feelings*, cited 93 times, difficulty and superficiality were recognized, understood as a feeling of knowing. The other allocations were similar to those presented by the totality of learning, but with inverted polarity, as in the cases: *Specificities of the task*, mentioned in 45 moments of the reports, due to the complexity of the content or lack of knowledge of the formulas, in which the students indicated that they knew how to explain the

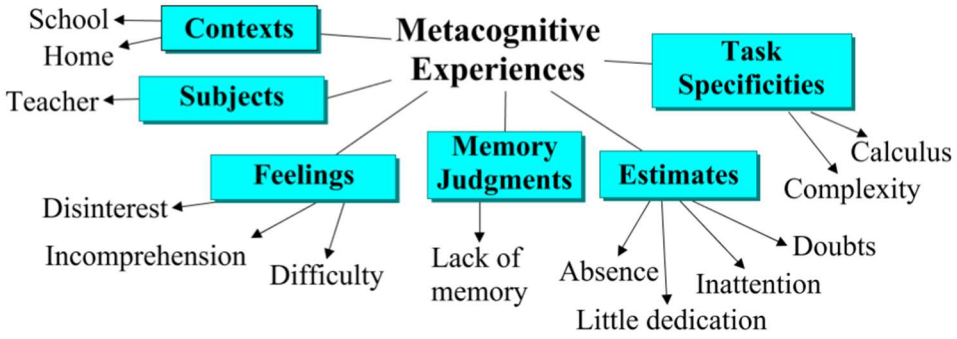
phenomenon, but not relating it to expressions; of memory (16 remissions) directly linked to memories, presented as lack of memory, signaling forgetfulness to the category *Judgments of memory*.

It was also possible to implicitly indicate the teacher in the *Subject* category, when the student signaled inattention in class, understanding here the teacher's explanation as part of the class and for *Context* the home and school as a place of study.

When explaining what happened in the questions that indicated "N", stating that they had not learned certain concepts, they presented justifications that were analyzed based on TDA, emerging twelve categories.

The mapping of the metacognitive experience for the analysis performed, based on the emerging categories from the sentences regarding the No Learning of Physics concepts, presented in Figure 5.

Figure 5 – Metacognitive experience for No Learning in Physics



Source: the authors

The *Estimates*, with 189 remissions, incorporate inattention, little dedication and absence, being representative of the effort undertaking and doubts as indicative of result accuracy.

The *Feelings*, listed 145 times, were mentioned for difficulty, disinterest understood as lack of satisfaction in learning a certain content, and incomprehension assumed as a feeling of knowing or not knowing.

For the *Specificities of the task*, only the complexity of some concepts/contents and calculations, both included in the Science of Ideas, with 46 manifestations and, to conclude, with 28 statements, we have the *Memory Judgments*, which bring memory related to forgetfulness.

Thus, as before, *Context* was assigned to the home and school, which are justified by the intrinsic indication of absences, being a situation that the absence of the student at school obstructed their learning, as well as the lack of dedication was referenced as not carrying out studies at home.

As for the *Subjects* presented implicitly in the data, represented by the teacher, when the student signals inattention in class, understanding that the teacher's explanation is part of the class.

From the analysis illustrated by means of the maps on the metacognitive experience, whether to justify the learning of concepts/contents in Physics or for not having achieved it, it was possible to show correspondences in the manifestations perceived and written by the students to the theoretically predicted manifestations, with some approximations of meaning. Thus, signaling that the students, when answering the questionnaires, possibly activated the metacognitive system through online monitoring, when they became aware of what they learned or not and the metacognitive reflection that occurred in the process of self-assessment of learning.

Final considerations

We understand that this study is of a complex nature and, therefore, theoretical deepening was necessary, in addition to the descriptive investigation, so that through the detailing of theoretical elements, the data collection and analysis instrument, it was possible to mint evidence that high school students perceive and understand their learning processes in Physics, are aware of what they know or not, their facilities and difficulties, or whether they are aware of the strategies they use to learn and how efficient they are or not.

Based on the research by Flavell and Efklides on the metacognitive experience, it was possible to build and propose an instrument for analyzing the perceptions and manifestations of the metacognitive experience, signaling that the students' reports of perceptions and descriptions when answering the self-evaluative questions analyzed in this article, showed indication that students are aware of what they know or not, their facilities and difficulties, the science of the strategies they use to learn and when these are efficient or not.

The analyzes carried out through TDA, of the information collected by the questionnaires about the perceptions of learning specific Physics content, reported by the High

School students, resulted in seventeen categories for Totality: friends, note, attention in class, comprehension, concept already learned, confidence, dedication, facility, interest, internet, reading, memory, nothing, no answer, relate, summary and homework; nine for Partiality: complexity, lack of attention in class, ignorance of the equations, difficulty, doubts, lack of memory, no answer, little dedication and superficiality; twelve for No Learning: calculus, complexity, inattention, disinterest, difficulty, doubts, absence, lack of memory, incomprehension, nothing, no answer and little dedication.

From the emerging categories, it was possible to find relationships with the elements of the metacognitive experience domain, theoretically predicted and presented in the proposed instrument for mapping the metacognitive experience.

It is noteworthy that the mapping representation was filled more intensely with categories emerging from justifications referring to perceptions of the totality of learning, signaling that students are able to describe their learning processes in detail when they identify that they actually happen. However, it was possible to identify a great similarity between the categories listed in Figures 4 and 5, which represent partial learning or no learning. These coherences in the justifications presented by the students are indicative that the students are aware of their learning process, that is, they present metacognitive reflection.

Through these representations (Figures 3, 4 and 5), it is possible to understand that academic self-concept, especially self-efficacy and self-perception, influence metacognitive experiences, that is, they are evidence that these students activated the metacognitive system through self-perception provoked by the metacognitive experience, but they did not present self-regulation, demonstrating the possibility of monitoring, even when there is no evidence of control, that is, self-regulation.

Therefore, from the understanding of perceptions by impressions or mental organizations, manifested in the process of building memories, both cognitive and affective, which interfere in the interpretations of learning situations that have occurred or not, captured by the questionnaires, it was possible to identify evidence of connections to theoretical elements of the metacognitive experience shown in Figures 3, 4 and 5, thus validating the proposed instrument.

With the validation of the analysis instrument, we understand the importance of proposing self-evaluative questionnaires that can be the target of studies when applied in the

daily life of the classroom, as a practice that aims to encourage metacognitive reflection and insertion of the metacognitive thinking process in the construction and development of metacognitive learning. According to Efklides (2001), lasting metacognitive feelings can start to become conscious, leading to an explicit control during problem solving.

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