Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 2178-5198
ISSN on-line: 2178-5201
Doi: 10.4025/actascieduc.v37i4.19955

Performance of first-year undergraduate students attending exact sciences courses in problems of the additive conceptual field

Lilian Akemi Kato, João Roberto Gerônimo, Valdinei Cezar Cardoso*, Marli Schmitt Zanella, Kleber Luciano Niro and Jusley Talita Grimes de Souza

*Departamento de Matemática, Centro de Ciências Exatas, Universidade Estadual de Maringá, Av. Colombo 5790, 87020-900, Maringá, Paraná, Brazil. *Author for Correspondence. E-mail: v13dinei@gmail.com*

ABSTRACT. This paper, which is part of a research based on the theoretical framework of the Theory of Conceptual Fields, investigated the performance of first-year undergraduate students attending Exact Sciences courses at the State University of Maringá, Brazil, with regard to the solution of problems in the additive conceptual field. Results obtained by these students evidenced some types of reasoning involved in additive structure that stand as an obstacle to the learning of Mathematics and may interfere with their future studies. Among the three classes that constitute the additive conceptual field proposed by Gérard Vergnaud, transformation problems had the highest rate of unsatisfactory results. However, errors committed by the students were detected in all problems of the diagnostic test. These results underscore the need for a broader discussion in academic environments that takes into account the difficulties in the test with regard to reasoning involving additive structure so that changes in the curricular structures of Exact Sciences courses may be fostered.

Keywords: theory of conceptual fields, additive structure, exact sciences, first-year undergraduates, Vergnaud's categories.

Desempenho dos acadêmicos ingressantes nos cursos de ciências exatas em problemas do campo conceitual aditivo

RESUMO. Este trabalho, que é parte de uma pesquisa com aporte teórico da Teoria dos Campos Conceituais, investigou o desempenho de acadêmicos ingressantes em cursos de Ciências Exatas da Universidade Estadual de Maringá na resolução de problemas do campo conceitual aditivo. Aqui se apresentam os resultados obtidos por esses acadêmicos, evidenciando alguns tipos de raciocínios envolvidos na estrutura aditiva que ainda permanecem como obstáculos para a aprendizagem da Matemática, podendo interferir na continuidade dos seus estudos. Dentre as três classes que constituem o campo conceitual aditivo, propostas por Gérard Vergnaud, os problemas de transformação foram os que apresentaram maior índice de resultados insatisfatórios. No entanto, em todos os problemas do teste diagnóstico, foram detectados erros cometidos por algum dos estudantes. Esses resultados nos alertam quanto à necessidade de uma discussão mais ampla no âmbito acadêmico, que leve em conta as dificuldades encontradas no teste em relação aos raciocínios da estrutura aditiva, para fomentar mudanças na estrutura curricular dos cursos de Ciências Exatas.

Palavras-chave: teoria dos campos conceituais, estrutura aditiva, ciências exatas, ensino superior, categorias de Vergnaud.

Desempeño de los académicos que entraron en los cursos de ciencias exactas en problemas del campo conceptual aditivo

RESUMEN. El presente trabajo, que hace parte de una investigación con aporte teórico de la Teoría de los Campos Conceptuales, investigó el desempeño de académicos que entraron en cursos de Ciencias Exactas de la Universidad Estadual de Maringá en la resolución de problemas del campo conceptual aditivo. Aquí se presentan los resultados obtenidos por estos académicos, evidenciando algunos tipos de razonamientos implicados en la estructura aditiva que aún permanecen como obstáculos para el aprendizaje de las Matemáticas, pudiendo interferir en la continuidad de sus estudios. Entre los tres tipos que constituyen el campo conceptual aditivo, propuestos por Gérard Vergnaud, los problemas de transformación fueron los que presentaron mayor índice de resultados insatisfactorios. Sin embargo, en todos los problemas del test diagnóstico, fueron detectados errores cometidos por alguno de los estudiantes. Estos resultados nos llaman la atención en cuanto a la necesidad de una discusión más amplia en el ámbito académico, que tenga en cuenta las dificultades encontradas en el test en relación a los razonamientos de la estructura aditiva, para fomentar cambios en la estructura curricular de los cursos de Ciencias Exactas.

Palabras clave: teoría de los campos conceptuales, estructura aditiva, ciencias exactas, enseñanza superior, categorías de Vergnaud.

Introduction

The Theory of Conceptual Fields (TCF) by Gérard Vergnaud is the theoretical framework founding this research whose objective is to investigate the performance of students admitted to Exact Sciences courses at the Universidade Estadual de Maringá (UEM) in problems of the additive conceptual field.

An analysis of operational invariants presented by these students in the resolution of such problems was carried out in Kato et al. (2013, p. 33, our translation), pointing some concern regarding their interference with "[…] failure and dropout rates in undergraduate courses"[1].

In this sense, this work used the same diagnostic instrument proposed in Kato et al. (2013) and was conducted with 309 freshman students attending Exact Sciences courses at the UEM in 2012, concerning the additive conceptual field, according to three classes – composition, transformation and comparison – proposed by Vergnaud (2009b).

This study goes beyond the mere mensuration of the knowledge of students attending Exact Sciences courses in college, because it contemplates a broader discussion about possible initial obstacles that may interfere with the performance of these students during their undergraduate studies, having dropout as the main consequence.

The concern with the permanence of students in Exact Sciences courses at the UEM has already been the object of a study conducted by Garcia et al. (2000) with first-year licentiate students, pointing that Higher Education dropout means an escape, failure or even a search for new horizons, and interferes with both the progress of disciplines and with the pedagogical project of courses, which emphasizes the importance of this discussion within the academic context.

Dropout rates in Exact Sciences courses have been turning the focus of some studies to a student's required skills, such as reading, interpretation, logical reasoning, etc., which interfere with his or her learning process (SILVA FILHO et al., 2007; CURY, 2008).

In this context, and also considering other studies about the reasoning involved in the additive conceptual field, like those by Magina et al. (2008), Santana (2010) and Vergnaud (1982), this work presents an overview of the performance level of first-year students attending Exact Sciences courses at the UEM concerning composition, comparison and transformation problems, according to the categories proposed by Vergnaud (2009b).

The questions proposed in the diagnostic instrument presented in Kato et al. (2013) contained six (06) problems, contextualizing situations of the everyday life of students that evoke different types of reasoning of the additive structure, because it is necessary to consider different degrees of complexity in order to provide an overview of how students master different situations of the additive conceptual field.

> The meaning of the situation for an individual seems to be one of the decisive factors for him or her to have a good performance in a given situation. Actually, this meaning is intimately linked to the variety of schemes that he or she has in his or her repertoire, which makes it possible to solve a given situation with greater or lesser competence (SANTANA, 2010, p. 139, our translation)[2].

The relevance of this study is not restricted solely to the academic community from the UEM, environment where the sample was selected, because we believe that the discussions deriving from the results obtained will contribute to inspiring future researches about skills and competences required for an individual to be able to play his or her role as a professional satisfactorily.

Theoretical foundations

According to Vergnaud (1993), the TCF is a psychological theory on the process of conceptualization of reality and seeks to describe and analyze the mid and long-term progressive complexity of mathematical competences that students develop inside and outside the school (VERGNAUD, 2009a).

When the author highlights the progressive complexity of mathematical competences, he refers to the development and learning that students go

[1] "[...] índices de reprovação e evasão nos cursos de graduação" (KATO et al., 2013, p. 33).

[2] "O significado da situação para o indivíduo parece ser um dos fatores decisivos para que ele tenha um bom desempenho em uma dada situação. Na verdade, esse significado está intimamente ligado à variedade de esquemas que o mesmo possui em seu repertório, que torna possível resolver uma dada situação com maior ou menor competência" (SANTANA, 2010, p. 139).

through when facing problematic situations. Such complexity depends on the enunciations of situations, on the students' cognitive structure, on the context involved, on data numerical characteristic and on how it is presented to students.

The comprehension of a concept by a student does not happen when he or she is confronted with one single situation; after all, a concept does not derive only from one situation. Each situation always involves more than one concept. One single concept or an isolated situation does not make up the entire process of acquisition of a certain piece of knowledge, because mathematical concepts draw their senses based on a variety of situations. Vergnaud (1993, p. 11, our translation) describes two main ideas on situations:

> That of variety: there is a great variety of situations in a given conceptual field; situation variables are a means to construct systematically the set of possible classes; that of story: the knowledge of students is elaborated by situations that they face and have mastered progressively, especially for the first situations likely to give a sense to concepts and procedures that one intends to teach them[3].

The additive conceptual field is constituted of different situations containing one or more addition or subtraction operations, besides concepts and theorems necessary for the mathematical reasoning to be applied in these situations (VERGNAUD, 1993).

According to Magina et al. (2008, p. 19, our translation), the additive conceptual field can be categorized according to types of reasoning required for the resolution of different situations.

> This categorization aims to offer a theoretical structure that may help teachers to understand the meaning of different symbolic representations of addition and subtraction, and to serve as a basis to experiences concerning this mathematical process in the classroom. The theoretical reason for distinctions in categorization is of both psychological and mathematical origin[4].

To master additive structures implies to be capable of solving several types of problematic situations, which means that to know how to operate a numerical calculation does not suffice. Magina et al. (2008) state that, behind a simple operation like 3+5, there may be problems so sophisticated that many students might have trouble solving it. Moreover, the ways to organize information of situations differ from each other, although the same arithmetic operation is used to solve them.

Santana (2010) and Vygotsky (1994) stress the relation between the role of social interaction, of language and of symbolization as the mastering of a concept by students progresses. In face of this, it is worth highlighting the importance of teachers as the mediators of teaching and learning processes that favor situations that enable students to develop schemes in the zone of proximal development.

The conceptual field of the additive structure is composed of concepts of cardinality, of measure, of temporal transformation (gaining and losing), besides relations of quantified comparison, of binary composition of measures, of composition of transformations and relations.

In this work, the problems used in the diagnostic test belong to the composition, the transformation and the comparison classes.

The composition problem class comprehends situations taken wholly and partly. This means to say that the problematic situation comprises two or more parts to identify the value of the whole. This composition may occur between measures, transformations and relations.

The transformation problem class involves a temporal idea, in which at times one loses, at times one gains, that is, transformations may be negative or positive. In this way, they are dynamic relations that establish relations between initial and final amount. Transformations occur between measures and between relations.

The comparison problem class occurs between measures, when one relation (comparison) links two measures.

Figure 1 displays the forms used to represent the relational calculus necessary for the resolution of the additive field problems.

The legends of Figure 1 will be used in the representation of the relational calculus of each one of the problems in the three classes.

Methodological procedures

This study counted with the participation of 309 students attending the first year of courses offered by the Center of Exact Sciences at the UEM, namely Mathematics, Physics, Chemistry, Statistics, and with students from the Department of Sciences of

[3] "A de variedade: existe grande variedade de situações num campo conceitual dado; as variáveis de situação são um meio de construir sistematicamente o conjunto das classes possíveis; a da história: os conhecimentos dos alunos são elaborados por situações que eles enfrentam e dominaram progressivamente, sobretudo para as primeiras situações suscetíveis de dar sentido aos conceitos e procedimentos que se pretende ensinar-lhes" (VERGNAUD, 1993, p. 11).

[4] "Esta classificação tem por objetivo oferecer uma estrutura teórica que auxilie o professor no entendimento do significado das diferentes representações simbólicas da adição e subtração, e de servir de base para o desenho de experiências sobre esses processos matemáticos em sala de aula. A razão teórica para as distinções na classificação é de origem tanto psicológica quanto matemática" (MAGINA et al., 2008, p. 19).

the Regional Campus of Goioerê. To carry out such a procedure, we used a diagnostic test made up of six problems elaborated by Kato et al. (2013), approaching different situations belonging to the additive conceptual field, and that contemplated the three major classes – composition, transformation and comparison – proposed by Vergnaud (2009b).

The methodological conception used in our work has an empirical and analytical nature with a descriptive design, being similar to the proposal by Campbell and Stanley (1979) referring to an experiemntal design that uses a single group of subjects, which answered the diagnostic test on the same day, but at different times, due to different courses and shifts. Table 01 describes the amount of participants in this research attending each one of the courses involved.

Data was collected from questionnaires in which the participants' private information was not identified. In this way, the individuals that were objects of this research had their privacy preserved and, after being informed about the objectives of the study, accepted to participate by signing an informed consent form allowing the use of their questionnaires in our work.

Considering our objective to present an overview of the performance level of students attending the first year of Exact Sciences courses at the UEM concerning composition, comparison and transformation problems, we present in Figure 2 the problems used in our diagnostic test, extracted from the work by Kato et al. (2013), as well as the relational calculus necessary to their resolution, and respective schemes.

P1, P4 and P6 are composition problems. This type of problem is characterized by the fact that two measures are composed so that they make room for another measure (P1), or two transformations that compose each other, resulting in a third transformation (P4), or by the fact that two relative states are composed so that they make room for another relative state (P6).

P3 is a comparison problem and is characterized by presenting a relation that links two measures.

P2 and P5 are transformation problems. P2 gives the initial (I) and the final (F) states and asks for the transformation occurred in the passage from a state to the other. P5 provides in its enunciation a relation (R1), a transformation (T) and asks for the relation (R2), based on R1 and T.

Analysis of results

In order to discuss the performance presented by all 309 participants of the research, we built four tables that describe the satisfactory and unsatisfactory results obtained in each class of problems.

Table 2 displays the results obtained in composition problems P1, P4 and P6.

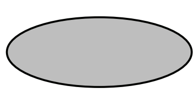
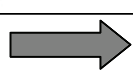
Form	Name	Represents
	Rectangle	A measure, that is, a natural number.
	Ellipse	A transformation or a relation, that is, a relative number.
	Horizontal curly brackets	Composition of elements of equal nature.
	Horizontal arrow	A transformation or a relation between elements of equal nature.

Figure 1. Symbols used to represent the relational calculus.
Source: Vergnaud (2009b apud KATO et al., 2013, p. 38).

Table 1. Distribution of the subjects investigated.

Course	Enrolled in 2012	Previous years[5]	Unspecified	Total
Statistics	11	7	0	18
Physics	55	0	0	55
Mathematics	75	13	0	88
Chemistry	64	45	7	116
Sciences	32	0	0	32
Total	237	65	7	309

Source: This research's instrument for data collection.

[5] Refers to students admitted in previous years but who were enrolled in the first year of the course.

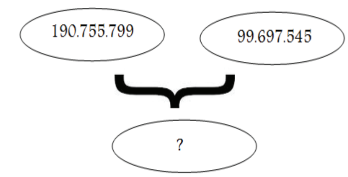
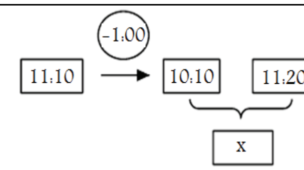
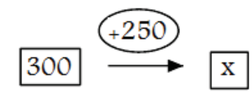
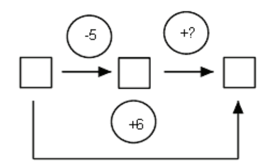
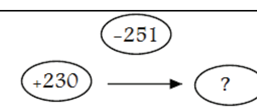
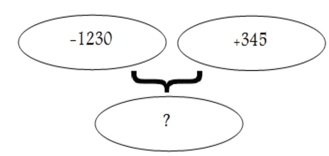
Problem Phrasing	Relational Calculus	Relational Calculus Scheme
P1: According to the demographic census of the *Instituto Brasileiro de Geografia e Estatística* [Brazilian Institute of Geography and Statistics] (IBGE), in 2011, for the first time in Brazil white people accounted for less than half of the total population. Among the 190,755,799 inhabitants registered in that year, 99,697,545 identified as being black, mixed, yellow or indigenous. What is the number of whites?	Relational calculus: *Measure 1 (M1) = 190,755,799; Measure 2 (M2) = 99,697,545 Composition: M1 – M2 = 91,058,254*	
P2: João will travel from Maringá to Campo Grande next Saturday, on a flight departing at 11h10min, and will arrive at 11h20, local time. What is the expected duration of this trip, knowing that Campo Grande's time zone is 1h behind Maringá?	Relational calculus: *Initial State (Ie) = 11h10min; Transformation (T) = - 1h; Final state (Fe) = 11h20min – (11h10min – 1h00min) = 1h10 min*	
P3: Carlos lent R$300.00 to Antônio. André has a debt with Carlos too but he owes R$250.00 more than Antonio. How much André owes?	Relational calculus: *Measure 1 (M1) = 300; Relation (R) = + 250; Measure 2 (M2) = M1 + R = 550*	
P4: Pedrinho's mother put some oranges in a basket for him to take it to his grandmother. On the way Pedrinho ate five oranges and felt worried, so he stopped by Mr. Raul's farm and picked more oranges. When he arrived at his grandmother's house, he counted the oranges in the basket and noticed that there were six more than the amount that his mother had put in the morning. How many oranges did Pedrinho pick at Mr. Raul's farm?	Relational calculus: *Transformation (T1) = - 5; Transformation (T2) = unknown; Transformation (T3) = + 6; T1 + T2 = T3*	
P5: What is the scoring difference of a basketball team that scored 230 points and conceded 251 points?	Relational calculus: *Relative State (R1) = + 230; Transformation (T1) = -251; Relative State (R2) unknown; R1 + T1 = R2*	
P6: Firisbrino has a property in Orticária and owes R$1,230.00 in property taxes to that city's government, which, in its turn, has a labor debt with Firisbrino of R$345.00. If the labor debt could be deducted from the property tax value, how much would Firisbrino still owe to the city government?	Relational calculus: *Relative state (R1) = -1230; Relative state (R2) = + 345; Relative state (R3) = - 885; R1 + R2 = R3*	

Figure 2. Problems of the diagnostic instrument.

Source: Kato et al. (2013).

Table 2. Results obtained in composition problems.

		Correct Relational Calculus and Wrong Result	Wrong or Inadequate Relational Calculus		No Relational Calculus and Wrong Result	Not done	Correct answers	Total
			Correct result	Wrong result				
	P1	2	0	0	1	0	15	
Statistics	P4	1	0	1	1	0	15	18
	P6	1	0	0	0	0	17	
	P1	12	0	1	1	0	41	
Physics	P4	1	0	0	4	0	50	55
	P6	7	0	0	0	48	0	
	P1	9	0	0	0	2	21	
Sciences	P4	0	0	5	7	0	20	32
	P6	7	0	0	1	2	22	
	P1	17	0	1	3	1	66	
Mathematics	P4	3	0	2	11	1	71	88
	P6	7	0	2	3	2	74	
	P1	20	0	3	0	0	93	
Chemistry	P4	2	1	12	2	2	97	116
	P6	11	0	0	2	4	99	

Source: This research's instrument for data collection.

In the category of composition problems, P4, of composition of transformations, was the problem which the students had more trouble interpreting in all courses investigated. In our view, the absence of the initial state in the problem, 'Pedrinho's mother put some oranges in a basket…' broke with the canonic form of resolution with which the students are familiar.

Conne (1979 apud VERGNAUD, 1982) observed that most of the procedures and explanations that students use during the resolution of problems can be interpreted based on the functional model: 'Where do I start? What do I do next? (addition or subtraction)?', but this model does not work for all types of situations, because it requires the identification of the starting point before beginning the resolution of the problem.

To that author, when the students force the resolution of a problem while supported on the functional model they invert the order of transformations or even make changes in gains or losses and vice versa, hence the cause of many errors in this type of problem. Such procedures were observed in the resolution of P4, as described in Kato et al. (2013). Table 3 shows the results obtained in said problem in comparison to P3.

Most of the students did not show difficulties when solving P3, and the incorrect results were a consequence, mainly, of a mistaken interpretation of 'how much one owes to whom'; in this case, the problem says: '[…] Carlos lent to Antonio […] André has a debt with Carlos too […]'.

Although the phrasing of the problem indicates debts (losses), the resolution is given by addition, which, according to Vergnaud (1996), is a complexity factor involved in additive reasoning. Table 4 displays the results obtained in transformation problems P2 and P5.

Transformation, measure problems, P2, and relation problems, P5, were those that presented the highest rate of unsatisfactory results in the test, possibly because they involve temporal transformations, which are dynamic and, according to Vergnaud (1982), not adequately represented by natural numbers.

Marthe (1979 apud VERGNAUD, 1982) states that problems that have opposite signs are generally harder than problems that have all magnitudes with equal signs. This author's work comes to the conclusion that the comprehension of the conceptual field of additive structures requires a long period of time and, in general, is not completely developed until 15 years of age.

The results presented in Tables 2 and 4 show that among all courses investigated at the UEM - Sciences, Statistics, Physics, Mathematics and Chemistry -, errors have been detected in at least one of the problems of the diagnostic test. Such errors are directly related to the mastering of the types of reasoning involved in each class of problems.

> The mastering of a conceptual field does not occur in a few months or years. On the contrary, new problems and new properties should be studied throughout several years if we want students to master them progressively. Trying to avoid conceptual difficulties serves for nothing; they are overcome as they are found and faced, but this does not happen all at once (VERGNAUD, 1982, p. 401, our translation)[6].

Table 3. Results obtained in the comparison problem.

	Correct Relational Calculus and Wrong Result	Wrong or Inadequate Relational Calculus		No Relational Calculus and Wrong Result	Not Done	Correct Answers	Total
		Correct Result	Wrong Result				
Statistics	1	0	0	0	0	17	18
Physics	7	0	0	0	0	48	55
Sciences	7	0	0	1	2	22	32
Mathematics	7	0	2	3	2	74	88
Chemistry	11	0	0	2	4	99	116

Source: This research's instrument for data collection.

Table 4. Results obtained in the transformation problem.

		Correct Relational Calculus and Wrong Result	Wrong or Inadequate Relational Calculus		No Relational Calculus and Wrong Result	Not Done	Correct Answers	Total
			Correct Result	Wrong Result				
Statistics	P2	1	0	1	0	1	15	18
	P5	0	0	1	1	0	16	
Physics	P2	0	0	0	3	2	50	55
	P5	0	0	0	1	2	52	
Sciences	P2	0	0	2	2	5	23	32
	P5	0	0	12	2	3	15	
Mathematics	P2	1	0	5	8	5	69	88
	P5	17	0	5	6	4	58	
Chemistry	P2	2	0	6	6	13	89	116
	P5	6	0	8	9	3	90	

Source: This research's instrument for data collection.

[6] "O domínio de um campo conceitual não ocorre em alguns meses, nem mesmo em alguns anos. Ao contrário, novos problemas e novas propriedades devem ser estudados ao longo de vários anos se quisermos que os alunos progressivamente os dominem. De nada serve tentar contornar as dificuldades conceituais; elas são superadas na medida em que são encontradas e enfrentadas, mas isso não ocorre de um só golpe" (VERGNAUD, 1982, p. 401).

In Table 5 we present unsatisfactory results obtained by course, in composition, comparison and transformation classes. We highlight that the total of answers (T) is given by the number of students in each course multiplied by the number of problems in each class. The number of errors (E), in turn, is the amount of wrong answers inside this total.

Table 5 evidences that transformation problems had the highest rate of errors inside the investigated group, and that comparison problems had the lowest rate.

According to Vergnaud (2009b), the notion of logical complexity involves the hierarchy of different logical objects of which the problems treat (population, debt, etc.), of the different properties of these objects in the context of the problem and of the different classes of problems in which these properties are used (composition, comparison and transformation problems).

To Vergnaud (2009b, p. 60), "[…] innumerous relations of the real world are, in fact, dynamic relations, in the sense that they link successive states of reality rather than simultaneous elements of reality"[7]. Such dynamic relations are involved in transformation problems.

In the case of temporal transformations, for instance, at times one loses, at times one gains. These relations can be dynamic, for example, Ana has 3 caramels and gained 5, so now she has 8 caramels, or static, for example, Ana has 5 caramels and Tina has 3 caramels, so together they have 8 caramels.

Final considerations

Situations involving types of reasoning of the additive structure are experienced by individuals from their very first years of schooling; however, there is a diversity of contexts inside a single situation that interfere with the degree of complexity of the relational calculus involved. According to Vergnaud (2009b, p. 212, our translation), "[…] the greater or lesser facility of the necessary numerical calculation and the order and presentation of information in the problem"[8] also contribute to the performance of students during the resolution.

In this sense, we understand that a student learns through actions realized when he or she interacts with problematic situations, and that competence is directly related to successive degrees of complexity; the success in mastering it may require a long period of time, whether in school activities or not.

Our research pointed that the development of types of reasoning involved in the additive structure of freshman students attending Exact Sciences courses is still under construction, which corroborates the affirmations by Vergnaud (2003) that competences, necessary for one to master the additive conceptual field should be developed throughout the school and academic life, in all areas of knowledge.

The focus of this article is on analyzing the amount of students that came to the right or wrong answers to the problem but, mainly, on investigating the performance of first-year students attending Exact Sciences courses at the State University of Maringá (UEM) regarding problems of the additive conceptual field that may interfere with the continuation of their studies in college.

Evidently, the results presented in Tables 2 and 4 do not implicate nor justify dropout or failure levels of students attending Exact Sciences courses, but are an indication of the importance of a more accurate study about their possible causes, as pointed out in the work by Garcia et al. (2000), which should promote discussions and changes in the pedagogical sphere of these courses.

The presentation of results by course does not have a comparison intention nor seeks to infer any assumptions about the first-year students, but aims to point possible difficulties students face when it comes to composition, transformation and comparison reasoning, which may become an obstacle to learning, due to the specificities of each field of knowledge.

Table 5. Amount of unsatisfactory results by course.

	Statistics			Physics			Sciences			Mathematics			Chemistry			Total of errors
Problems relating to	T	E	%	T	E	%	T	E	%	T	E	%	T	E	%	
Composition 3 problems	54	6	11.11	165	24	14.55	96	21	21.88	264	47	17.80	348	56	16.09	154
Transformation 2 problems	36	3	8.33	110	6	5.45	64	26	40.63	176	44	25.00	232	40	17.24	119
Comparison 1 problem	18	0	0.00	55	0	0.00	32	1	3.13	88	13	14.77	116	9	7.76	23
Total	108	9	8.33	330	30	9.09	192	48	25.00	528	104	19.70	696	105	15.09	296

Source: This research's instrument for data collection.

[7] "[...] inúmeras relações do mundo real são, de fato, relações dinâmicas, no sentido de que elas ligam estados sucessivos da realidade e não elementos simultâneos da realidade" (VERGNAUD, 2009b, p. 60).

[8] "[...] a facilidade maior ou menor do cálculo numérico necessário e a ordem e apresentação das informações no problema" (VERGNAUD, 2009b, p. 212).

However, the discrimination of the courses investigated aspire to draw the attention of teachers who are directly involved about this issue, allowing them to carry out, by means of their teaching activity, interventions that favor a learning that is not limited only to the student, but that also makes them adopt an attitude as that of a researcher of their own practice (SANTANA, 2010). Based on this observation, we infer that changes, whether in the pedagogical projects of courses, whether in the progress of the disciplines, are necessary to favor the development of the cognitive structure and of knowledge, allowing students to expand their skills and competences to solve more complex problems that might arise in their academic and professional journey, in which there is some interference by the additive field.

Referências

CAMPBELL, D. T.; STANLEY, J. C. **Delineamentos experimentais e quase-experimentais de pesquisa**. Tradução de R. A. T. Di Dio. São Paulo: EPU-Edusp, 1979.

CURY, H. N. **Análise de erros**: o que podemos aprender com as respostas dos alunos. 1. ed. 1. reimpr. Belo Horizonte: Autêntica, 2008.

GARCIA, N. M.; ABDALA, A. O.; MATSUSHITA, A. M. Aceleração de aprendizagem – um inibidor da evasão na universidade. **Acta Scientiarum.** v. 22, n. 1, p. 103-111, 2000.

KATO, L. A.; ZANELLA, M. S.; SANTOS, V. K. M.; GERÔNIMO, J. R.; NIRO, K. L.; SOUZA, J. T. G.; CARDOSO, V. C. Estratégias de resolução em problemas do Campo Conceitual Aditivo: um estudo com alunos ingressantes nos Cursos de Ciências Exatas. **Boletim GEPEM**, v. 1, n. 62, p. 33-53, 2013.

MAGINA, S.; CAMPOS, T. M. M.; NUNES, T.; CITINARA, V. **Repensando adição e subtração**: contribuições da teoria dos campos conceituais. 3. ed. São Paulo: PROEM, 2008.

SANTANA, E. R. S. **Estruturas aditivas**: o suporte didático influencia a aprendizagem do estudante? 2010. 344f. Tese. (Doutorado em Educação Matemática)-Universidade Pontifícia Católica de São Paulo, São Paulo, 2010.

SILVA FILHO, R. L. L.; MOTEJUNAS, P. R.; HIPOLITO, O.; LOBO, M. B. C. M. A evasão no ensino superior brasileiro. **Cadernos de Pesquisa**, v. 37, n. 132, p. 641-659, 2007.

VERGNAUD, G. A Classification of cognitive tasks and operations of thought involved in addition and subtraction problems. In: CARPENTER, T. P.; MOSER, J. M.; ROMBER, T. A. (Ed.). **Addition and subtraction**: a cognitive perspective. Hillsdale: Lawrence Erlbaum, 1982. p. 39-59.

VERGNAUD, G. Teoria dos campos conceituais. In: SEMINÁRIO INTERNACIONAL DE EDUCAÇÃO MATEMÁTICA DO RIO DE JANEIRO, 1., 1993. Rio de Janeiro. **Anais...** Rio de Janeiro: Projeto Fundão – Instituto de Matemática – UFRJ, 1993. p. 1-26.

VERGNAUD, G. A teoria dos campos conceituais. In: BRUN, J. (Ed.). **Didáctica das matemáticas**. Lisboa: Instituto Piaget, 1996. p. 155-191.

VERGNAUD, G. A Gênese dos campos conceituais. In: GROSSI, E. P. (Ed.). **Por que há ainda quem não aprende?** A teoria. Petrópolis: Vozes, 2003. p. 21-60.

VERGNAUD, G. The theory of conceptual fields. **Human Development**, v. 52, n. 2, p. 83-94, 2009a.

VERGNAUD, G. **A criança, a matemática e a realidade**: problemas do ensino da matemática na escola elementar. Curitiba: UFPR, 2009b.

VYGOTSKY, L. S. **A formação social da mente**: o desenvolvimento dos processos psicológicos superiores. 3. ed. São Paulo: Martins Fontes, 1994.

Received on March 1, 2013.
Accepted on September 27, 2013.