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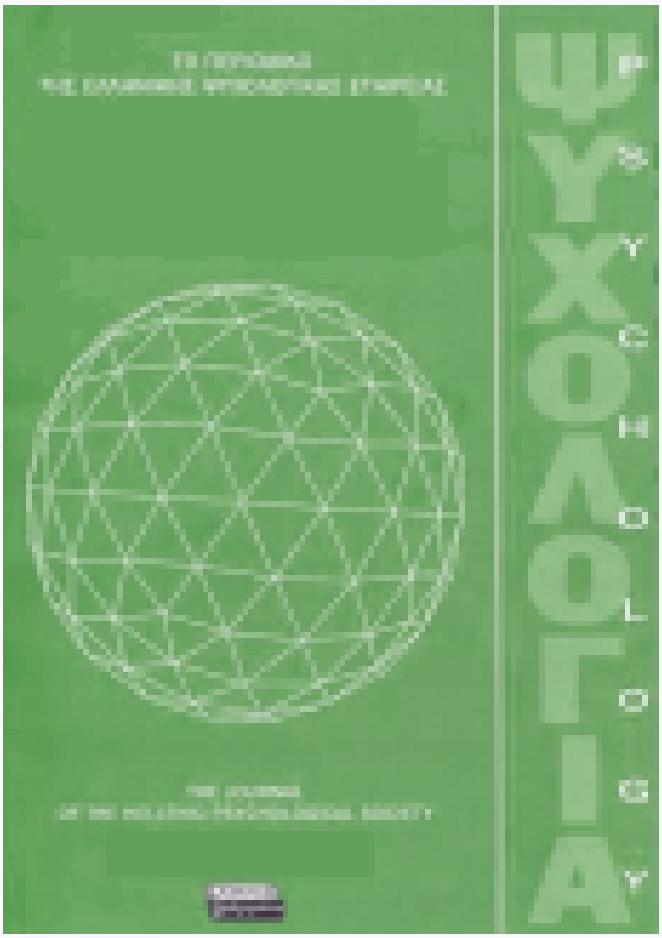

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The role of conflict and information in the resolution of problems of unfamiliar physics concepts

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ABSTRACT The present study examines the role of conflict in the process of production of generalized knowledge. The experimental method is used, which is applied to the case of problem solution in the area of unfamiliar physics concepts (an ability task). 243 students aged 14-15 from high schools in the Athens area participated in the study. Conflict emerges from the manipulation of two independent variables: availability of information (none, some, continuous) and awareness or not (having the correct answer to the problem). The measurements relate, on the one hand, to the elaboration of conflict at the level of self-image, image of the other and image of the task and, on the other hand, to the role of conflict in the understanding of an unfamiliar physics concept and the possibility of its application in problem solving. The results show that the greatest conflict is created in the case of individuals who have continuous access to the necessary information and are awarded with the correct answers. These individuals perceive themselves more positively, at the expense of the «other» and of the experimental task. The role of conflict in the production of generalized knowledge appears in a similar post-experimental task, in which the same individuals understand the new knowledge better and apply it.

Key words: Conflict, Availability of information, Ability task, Generalized knowledge.

The objective of this research is to study the role of conflict and its elaboration in the resolution of problems having to do with unfamiliar concepts of physics. We explore the importance of information for the solution of the above problems and its relationship with conflict. In this particular case the experimental paradigm is the concept of «light-year».

Conflict

The term «conflict» has many meanings, as it encompasses a large number of phenomena: from dialogue, dialectic relationship, negotiation, interaction, disagreement, divergence, difference, competition, rivalry it can reach an extreme form, such as corruption, violence, coup d'état, homicide and war. We can, therefore, define conflict as a socio-psychological state in which individuals or groups become involved when there is a difference between them. This difference may be real or symbolic, and may take the form of social rules, advantages, goals, anticipation, values, interests, beliefs, opinions, knowledge, information etc. The researchers, in their attempt to construct a theory, have pinpointed certain central reference axes, such as the causes of conflict, the forms it takes, the modes of solution and the results it produces. Many social scientists conclude that conflict often has positive results, causing social change.

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Some others, like the functionalists (who wage battle for the conservation of the status quo, of established social structures and relationships in society), consider the conflict to be bad, destructive, damaging and harmful to society.

Conflict appears as an active principle both at societal and individual level. The concept of the conflict defines the research field of Social Psychology and is placed in its beginning. In 1864 Carlo Cattaneo presented «a new field, the Social Psychology, and a key term, the conflict, which was to orientate the research towards it» (Doise, 1995, p. 200).

Researchers who doubt one-sided reduction both for the individual and the collective subject, even for society, place conflict at the center of the relationship between the individual and society (Moscovici, 1979; Mugny, 1982; Papastamou & Mugny, 1983; Moscovici & Mugny, 1987; Papastamou, 1989; Pérez & Mugny, 1993; Mugny, Oberlé, & Beauvois, 1995; Mugny & Pérez, 1998). In this theoretical framework are included studies in the process of minority influence, in which conflict is an essential prerequisite for innovation. Social conflict is confronted as an interpretive principle, which governs the processes of social influence. Conflict, its elaboration and the modes of its resolution comprise a general theoretical model which incorporates the characteristics of the source, the object of conflict (task, message), the receiver of the message and the level of influence: manifest - latent, direct - indirect, public - private, conscious - unconscious, compliance - conversion (Pérez & Mugny, 1993; Madoglou, 2003).

This model of conflict elaboration provided us with the theoretical approaches and the methodological tools for the present study. Without entering into the details of this model, we can concentrate on the elements applicable to our case, which, basically, does not refer to an explicit social influence in the classic sense of the term: source-message-receiver-change. In our case conflict is a generative element of learning, the assimilation of new knowledge, which is realized in the passage from superficial to abstract and generalized knowledge. Learning and assimilation are functions of conflict and its elaboration. When we ask students to define terms that under normal circumstances they do not know (because they have not been taught them at school), they arrive at a condition of socio-cognitive conflict (the difference between the new element and the pre-existing «void» which it relates to). Students know that there exists a correct answer to these problems, but they are ignorant of it. Conflict intensifies when we ask them to use productively the concepts in order to solve various problems. Furthermore, the conflict is especially aggravated when we inform them of the correct solution to the problems. The elaboration of this conflict will result in the incorporation of the new knowledge into the pre-existing socio-cognitive system. This will appear both as an increase in correct answers in relation to these concepts in a post-test and as a constructive use of the concepts in similar problems.

In our experiment the «influence source» is symbolically the expert (without a physical presence) who has a generalized, abstract knowledge. The object of conflict -in this case the experimental task- concerns the understanding of the concept «light-year» and its application in the solution of problems. This task of solving a problem is a task of ability in which only one specific answer is correct and it is possible to assess objectively which answers are wrong. It is a task which requires a special intellectual effort to be resolved. The individual will attempt to give the most satisfactory and correct answers. At this level there is an involvement of the identity of the individuals, since they wish to present a pleasing image of themselves. The conflict involves their abilities. No other form of conflict emerges, since each individual's answers are private, written and anonymous. In ability tasks what characterizes the psychological condition of the involved subjects is the uncertainty which is created

because of their difficulty. The special «source» has great credibility, because it disposes the correct information and obliges the «target» to be dependent on it (information-dependence). The «source» is a guarantee of the objectively correct answer and of the informational value of the content of its message. On a manifest, direct level the individual-target will resolve the problems according to the level of the information he/she has. The application of the information will be superficial, simply mimetic. On the latent, indirect level, where confirmation is sought, knowledge will be stabilized in time and there will be generalization to other similar tasks. The thought of the target will be convergent: the information provided by the source is used as a single point of reference for the creation and stabilization of knowledge.

Information

The role of information in problem solving (ability tasks) is central, because it comprises the nucleus around which the representation of the problem will be constructed. This role, however, is achieved on condition that the information is, firstly, available and, secondly, accessible.

In cognitive psychology there is a distinction between accessibility and availability of the information. Availability reflects the retrieval properties of long-term memory. However, the recollection does not always occur. Even though people have the solution to a current problem already stored in memory, they often cannot recall it. This is a problem of accessibility. This distinction shows that information may be available but inaccessible, hard to approach (Tulving, 1967). The level of access to an information stored in memory depends on the level of its organization within a cognitive context. An organized information is coherent, consistent and can be generalized.

More generally, information as a source of knowledge leads to the construction of a mental representation. In the case of problems, the type of representation is one of the most important factors in the ease of which they can be solved, since it will regulate the manipulations of the solver in relation to the problem (Hayes, 1978). The task of understanding the problem itself, that is the application of an internal representation of the situation and the manipulations relating to it, has a catalytic effect on the solution of the problem, given that certain representations contain much simpler manipulations of elaboration than others (Kotovsky, Hayes, & Simon, 1985). Problems can be represented on different levels of abstraction (Gick & Holyoak, 1980). Abstract representations are the result of an abstraction of the substantive -generic-content or of the main points of a situation (Kintsch & Van Dijk, 1978). Superficial representations, conversely, are based on various details appearing in the problem. The successful confrontation of a problem requires the construction of an adequately abstract, generalized, «scientific» representation, which solvers can manipulate and use when analyzing various situations (problems).

The confrontation and resolution of problems of physics, such as those used in our experimental paradigm, present certain characteristics, which are connected to physics as a cognitive domain. Specifically, this is a semantically rich cognitive domain, that is to say, an area of knowledge where large packets of information are necessary for the confrontation of problems (Bhaskar & Simon, 1977). It is also a typical domain, that is a domain which, apart from including a great deal of knowledge, depends on generally accepted logical principles sufficient to lead to the resolution of problems (Larkin, 1981). Finally, the manner of confrontation of physics problems differs significantly between «experts» and «novices». Experts confront the problems according to fundamental laws of physics, applying general principles of solution, while novices confront them according to their superficial characteristics

(Chi, Feltovich, & Glaser, 1981). Information, therefore, becomes a qualitatively different source for experts and novices, since for the latter the process of incorporating new knowledge into the existing cognitive system is impeded, because there is no coherent cognitive schema similar to the information.

This difference appears through the solution process of physics problems, in which the schemata of resolution which are at the disposal of both teams are defined. Students who have not seen similar problems present the characteristics of novices. Problem solution for the students means calculating one or more unknowns. In order to cope with this process, even when they use formalized means (formula), they avoid qualitative explanations requiring multiple generalized representations of a physical phenomenon.

Physics problems are used in the study of the individual ability of choice of the appropriate relation between the data, as well as in the study of the manipulation of these relations. The solution of these problems is effected through a productive, constructive process of application of general knowledge and rules to the specific data (a passage from the superficial to the generalized knowledge). This process assumes the elaboration of conflict which is created by the unknown task and which leads to change (innovation - acquisition of new knowledge). The task is characterized as a «minority» because:

1. The concept of «light-year» is unknown to our experimental subjects, since they have not been taught it within the school framework.

2. The anchoring of the concept of «light-year» as a significant leads to the familiar concepts of «year» and «light», creating confusion as to what is defined -signified-, which is a unit of measurement of distance.

3. It belongs to the cognitive area of physics, in which the confrontation of problems requires the manipulation of generally accepted logical principles and large packets of organized knowledge.

Method

Participants

The sample consists of 243 students aged 14-15 from Athens high schools (gymnasium). This age corresponds to the third year of high school. The participants were assigned randomly to the experimental conditions, which we assume were equivalent concerning their abilities to the experimental task. The specific age group of the sample was determined by the experimental task, which consists of the definition and utilization of physics concepts unknown to the experimental population. The concepts were selected after checking the appropriate schoolbooks for the central concept of «light-year», which we wanted the students participating in the study not to know, or at least not to have been taught.

Independent and dependent variables

The independent variables in this experiment are:

a) The availability of information (non, some, continuous) regarding the concept of «light-year».

b) The awareness of subjects about correct answers (yes, no).

The manipulation of the two independent variables (availability of information and awareness) leads to six experimental conditions (3 X 2), as the following table shows, where the number of subjects per condition is also presented.

The dependent variables are the subjects' responses to the experimental task, which consists of:

a) A questionnaire of knowledge relating to questions about seven familiar and unfamiliar physics concepts. For each physics concept four alternative answers are given, of which only one is correct.

	Continuous availability of information	Some availability of information	No availability of information
YES	35	43	40
Awareness			
NO	35	44	46

b) Two problems of increasing difficulty, which the students must solve, giving reasons for their answers. The problems relate to the concept of «light-year». The solution of the first problem requires the simple reproduction of the definition of «light-year», while the second requires its understanding and application, that is its productive use.

c) Questions relating to: i) the students' self image, ii) the image of the task, iii) the image of their teachers in educational practice.

The dependent variable relates to the knowledge of the unfamiliar physics concept of «light-year», the ability to apply this knowledge for the solution of problems, its generalization, the image the students have of their self in relation to the experimental task they completed, the image they have about the experimental task itself and the image they have about their teachers.

Procedure

The 243 students of the present research participated in a pre- and post- experiment.

Pre-test

The study consists of six stages. In the first stage the objective of the study is presented and then the students answer a series of personal questions (age, sex, school and interest in physics concepts and solving problems).

The second stage consists of the manipulation of the first independent variable, which involves the availability (none, some, continuous) of the information regarding the concept of «light-year». The related information is given in a text which includes the definition of «light-year», an example and additional elements about the relationship between the information in the text and the problems which follow (the relation between space, velocity and time). In the presentation the students receive the following message: *Useful information that has to be considered for the solution of the follow problems: The distances among the stars are tremendous. In order to measure these distances, we use as a unit of length in astronomy the light-year. One light-year is the distance that the light covers in one year. The speed of the light is 300,000 km/sec. For example, our galaxy consists of many stars. The position of these stars forms a spiral tray. The diameter of this spiral tray is 100,000 light-years. The speed of the light is the maximum possible. Theoretically, nothing can move with speed greater than 300,000 km/sec. To measure the distance that a body covers when moving in a linear regular motion with speed smaller than the speed of the light, we usually use the kilometer. In this case, the space that the body covers is given from the formula s = v.t, where v is the speed of the body and t is the time that the moving body needs to cover this space. If we solve the formula s = v.t, we can calculate the speed or the time.*

In the condition of «no availability» no useful information is presented to the students. In the condition of «some availability» the information is presented for a short time, the students read it

and then it is removed. In the case of «continuous availability» the information remains at the disposal of the students for the duration of the experimental procedure.

In the third stage the students fill in the questionnaire of knowledge regarding seven physics concepts (space, astral-year, velocity, light-year, time of motion, orbit of the earth and distance), choosing the correct answer among the four options given for each question.

The fourth stage consists of the solution and justification of the answers to the following two problems relating to the concept of «light-year».

Problem 1: *The light of a star of a neighboring galaxy needs one year to reach the Earth. What is the distance of the star from Earth?*

Problem 2: *A spaceship needs 24 years to go from planet A to planet B. What is the distance between the two planets, if the spaceship moves, in relation to the Earth, at a speed of 300,000 km/sec?*

In the fifth stage we introduce the manipulation of the second independent variable, which relates to the students' awareness -or lack thereof- of the correct answers and the reasoning behind them. A text in which appear the correct answers to the problems and the reasoning behind them is presented or not to the subjects, in order to be or not to be awarded. The text is the follow:

The correct answers to the above problems are:

Problem 1

Answer: *The distance is one light-year.*

Justification: *A light-year is the distance that covers the light in one year (according to the definition).*

Problem 2

Answer: *The distance between the two planets is 24 light-years.*

Justification: *Since the spaceship moves with the speed of the light (300,000 km/sec), it covers a distance of one light-year in one year. Consequently, it covers the distance of 24 light-years in 24 years.*

In the sixth -and final- stage an opinion questionnaire is presented to the students, consisting of three thematic units. In the first we ask the students to describe how they felt during the course of the task. In the second the students express their opinions about the task. The third, finally, contains questions relative to their teachers and their role in educational practice. These three units, that correspond to the representation of the self, the task and the other (Doise, 1973; Codol, 1969; Abric, 1987), define the elaboration of conflict. Each unit consists of propositions for which the subjects have to settle themselves on a five-degree scale.

The combination of the two independent variables, which are introduced in the second and the fifth stage respectively, leads to the follow experimental conditions:

1. Continuous availability of information and awareness: Students read the «useful information» which they must take into account for the solution of the problems. The information remains at their disposal during the experimental procedure, and the students are awarded with the correct answers to the problems.

2. Some availability of information and awareness: Students read the «useful information» which they must take into account for the solution of the problems and they are awarded with the correct answers to the problems.

3. No availability of information and awareness: Students receive no «useful information», but they are awarded with the correct answers to the problems.

4. Continuous availability of information and no awareness: Students read the «useful information» which they must take into account for the solution of the problems, the information remains at their disposal during the experimental procedure, but they are not awarded with the correct answers to the problems.

5. Some availability of information and no awareness: Students read the «useful information» which they must take into account

for the solution of the problems, but they are not awarded with the correct answers to the problems.

6. No availability of information and no awareness: Students receive no «useful information» and they are not awarded with the correct answers to the problems.

Post-test

Ten days later a post-test follows, consisting of the personal questions, the knowledge questionnaire about the seven physics concepts, two problems of increasing difficulty to be solved -similar to the problems in the third stage of the pre-test- and the opinion questionnaire. The problems are the follow:

Problem 1: *The light of a star of a neighboring galaxy covers the distance of one light-year to reach Earth. What is the time the light needs to cover this distance?*

Problem 2: *A spaceship covers a distance of 15 light-years to travel from planet A to planet B. What is the time the spaceship needs to cover this distance, if it moves, in relation to the Earth, at a speed of 300,000 km/sec?*

For each stage both in the pre- and the post-test the students are provided with limited time. At the completion of each stage, we collected the students' answers and we continued to the next stage. The total procedure did not exceed one school hour (45 minutes).

Hypotheses

The solution of problems requiring application of an unfamiliar physics concept creates a conflict of abilities, which is unpleasant to the individual and damaging to the socio-psychological identity. During the process of the resolution of this conflict the individuals will attempt to preserve a positive self-image, attributing their inability to external factors -that is to say, devaluing-, on the one hand, the experimental task involving the concept and, on the other, the educational framework relating to it.

The information relating to an unfamiliar physics concept is a necessary but not sufficient condition for the understanding and application of the concept in the solution of problems. In order to be sufficient, the information not only must be available but also accessible and organized into a complex representation. Thus, the elaboration of conflict initiates a constructive process of incorporating the «new» (unknown) concept into the pre-existing socio-cognitive system. Generalized schemata of resolution are created, which will appear, with some delay, in similar tasks.

Therefore, it is expected that individuals who continually possess the information (available and accessible), in contrast to individuals who possess the information for a short time (available but not accessible) and those who do not possess it at all (neither available nor accessible):

a) Will present an increased percentage of correct answers.

b) Will be those with the greatest conflict of ability, because of the non-productive application of the available and accessible information during the problem solving. This conflict will be elaborated, on a manifest level, within the framework of preservation of a positive self-image and at the expense of the image of the object and of the teachers. On a latent level, after a certain period of time, the elaboration of conflict will lead to a generalization of knowledge (an amelioration of performance in similar problems).

The above features are enhanced in the case of individuals who are awarded with the correct solutions to the problems. In this case the awareness, as an added piece of information, both enhances the role of the pre-existing information and intensifies the socio-cognitive activity of the subject. The subject concentrates

on the information which emerges from the awareness of the correct answers, and his/her thoughts converge towards it.

Results

Pre-test: Knowledge of the concept of «light year» and its application in the solution of problems

The results concerning the knowledge of the concept of «light-year» (an unfamiliar physics concept) show that only 24.7% of the students know its definition. This percentage concerns the condition of «no availability», under which the «useful information» is not presented to the students at all. The percentages for the conditions of «some availability» (the information is presented for a short time) and «continuous availability» (the students have continuous access to the information) are 32.9% and 61.4% respectively. The differences between the three experimental conditions are statistically significant ($X^2 = 23.52$, $df = 2$, $p < .0001$).

Table 1 shows the percentages of answers and justifications of the students to the problems both in total and relatively to the availability of the information. We regard correct answers-justifications those in which the usage of the data leads to correct judgements, and incorrect answers-justifications those in which the usage of the data leads to incorrect judgements. Finally, we regard intermediate answers-justifications those in which the usage of the data of a problem appears either fragmented or incorrect. For example, the concept of «light-year» is used as a measure of time, the formula for linear motion is used as well as a measure of distance, the units of measurement are converted etc. Furthermore, mathematical manipulations are performed, but the given answer is a personal estimation and not the result of the manipulations.

Concerning the total answers, we see a decrease in the percentage of correct answers from the first (13.2%) to the second (3.7%) problem ($X^2 = 46.86$, $p < .0001$), as well as in the correct justifications (from 10.3% to 3.7%, $X^2 = 32.19$, $p < .0001$). This tendency is noticeable in all three conditions regarding the availability of the information. The above information is indicative of the varying degree of difficulty of the problems, since the solution of the first one requires the simple reproduction of the definition of «light-year», while the solution of the second requires understanding and application of this definition.

As to the availability of the information, individuals who had continuous access to it during the solution of the problems present increased percentages of correct answers and justifications relatively to the individuals who did not have any access to the information and to those who had limited access. The small percentage of correct answers and justifications under the condition of «some availability» of the information compared to the condition of «no availability» may be due to inadequate examination of the available but not accessible information. Moreover, if we take into account the increased percentages of intermediate answers, then it is possible that the simple reading of the text of «useful information» leads the individuals to cognitive manipulations of the problems only in regard to their superficial structure. This is a typical «novice» behavior. Elaboration of this type trapped the individuals into incomplete manipulations (intermediate answers-justifications), not yet efficacious in giving the correct answer. This cognitive «obstacle» does not exist for the individuals under the condition of «no availability» (neither available nor accessible information).

Pre-test: Representation of the self, the task and the other

Self-image

The factor analysis applied to the students'

Table 1
Percentages of «correct», «intermediate» and «incorrect» answers and justifications in the problems in total and in relation to the information (*N* = 243)

Problems		Total of information	Continuous availability of information	Some availability of information	No availability (*df* = 6)	X^2
Answers Problem 1	Correct	**13.2**	**20**	**8**	**12.8**	**24.52*** **
	Intermediate	20.2	25.5	23	12.8	
	Incorrect	33.7	42.9	29.9	30.2	
	No answer	32.9	11.4	39.1	44.2	
Justifications Problem 1	Correct	**10.3**	**18.6**	**3.4**	**10.5**	**28.47*** **
	Intermediate	21	31.5	24.1	9.3	
	Incorrect	27.2	27.1	21.8	32.6	
	No answer	41.6	22.9	50.6	47.7	
Answers Problem 2	Correct	**3.7**	**10**	**0**	**2.3**	**18.62** **
	Intermediate	43.6	47.1	50.6	33.7	
	Incorrect	14.8	14.3	11.5	18.6	
	No answer	43.6	28.6	37.9	45.3	
Justifications Problem 2	Correct	**3.7**	**10**	**0**	**2.3**	**20.93***
	Intermediate	43.2	45.7	49.4	34.9	
	Incorrect	6.6	10	2.3	8.1	
	No answer	46.5	34.3	48.3	54.7	

*** $p < .0001$, ** $p < .005$, * $p < .002$

answers about the image they have of themselves presented four factors, interpreting 59.5% of the total variance (Table 2). The first factor (30.2% of the total variance) summarizes a positive perception of the image of self. The comprising elements are: sure of my knowledge, calm, pleased, satisfied, not anxious, bold, responsible, creative, concentrated, productive, skillful, free, enthusiastic, comfortable, prepared and free. The second factor (13.7% of the total variance), which refers to the pressure felt by our subjects regarding the experimental task, collects the adjectives: sure of my knowledge, nervous, satisfied, anxious, repressed and uneasy. The characteristics that appear strongly in the third factor, which explains 8.4% of the total variance, are: bold, irresponsible and distracted. These characteristics imply the absence of involvement with the task. The fourth factor (7.2% of the total variance) comprised the characteristics displeased, skillful and unprepared, implying the lack of preparedness for the task.

The factors which differentiate the conditions among them are the first -positive self-image- [$F(2,226) = 5.58$, $p < .004$], relative to the independent variable of information, and the fourth -lack of preparedness- [$F(5,223) = 2.46$, $p < .034$], relative to the information and the awareness, as shows the One-Way ANOVA analysis.

The *LSD* test applied to the factor means of positive self-image in relation to the information shows that the students under the condition of

Table 2
Means of the characteristics of self-image (on a five-point scale) and the results of factorial analysis (*N* = 228)

Characteristics	*Means*	*F1*	*F2*	*F3*	*F4*
1. Sure - Unsure of my knowledge	2.83	**.60**	**.37**	.07	.29
2. Nervous - Calm	3.39	**-.55**	**.51**	.05	-.04
3. Displeased - Pleased	3.25	**-.63**	-.13	.19	**.39**
4. Satisfied - Dissatisfied	2.85	**.59**	**.49**	-.02	-.16
5. Anxious - Not anxious	3.52	**-.48**	**.59**	-.03	-.19
6. Bold - Hesitant	2.53	**.50**	-.20	**.39**	-.25
7. Irresponsible - Responsible	3.65	**-.43**	.09	**.64**	-.15
8. Creative - Not creative	2.35	**.59**	.23	.21	.27
9. Distracted - Concentrated	3.52	**-.47**	-.01	**.69**	-.07
10. Effective - Ineffective	2.61	**.65**	.34	.14	.02
11. Skillful - Unskillful	2.56	**.63**	.13	.20	**.43**
12. Repressed - Free	3.64	**-.37**	**.60**	.02	.03
13. Enthusiastic - Disappointed	2.71	**.64**	.21	.12	-.02
14. Uneasy - Comfortable	3.63	**-.54**	**.60**	-.21	.13
15. Unprepared - Prepared	2.32	**-.43**	-.16	.04	**.64**
Total variance	59.5%	30.2%	13.7%	8.4%	7.2%

«continuous availability» of information (m = -.21) and under the condition of «some availability» of information (m = -.11) have a more positive self-image than the students under the condition of «no availability» of information (m = .29), (LSD = .50, p < .002 and LSD = .40, p < .01, respectively).

The factor of lack of preparation for the students who possessed the information is perceived more highly by those who did not have any information (m = -.25) than by the students who had the information continuously (m = .32), (LSD = .57, p < .017). There is also a differentiation as to the information provided under the condition of continuous availability of information during the solution of the problems. The students who did not possess information perceive more highly the factor of lack of preparation than those who did (m = -.26, as opposed to m = .32, LSD = .58, p < .016). In the case of absence of awareness, the students under the condition of «continuous availability» (m = -.26) perceive more highly the factor of lack of preparation than the students under the condition of «some availability» (m = .27), (LSD = .54, p < .019).

Image of the task

The factorial analysis performed on the data of the image of the task showed three factors, which interpret 56.1% of the total variance (Table 3). The adjectives which show a high charge in the first factor (36.8% of the total variance) are: organized, original, significant, comprehensible, familiar, creative, concrete, accessible, substantive, specialized, upgraded, logical, interesting. These adjectives refer to a positive dimension of task's image. This factor summarizes the «positive image» of the task. The adjectives that present high charge in the second

factor (11.9% of the total variance) are: original, difficult, unknown, unusual. They refer to the «positive difficulty» of the task. The adjectives concentrated in the third factor (7.5% of the total variance) are: difficult, ordinary, specialized, trite, disorganized and incomprehensible. They summarize the «negative difficulty» of the task.

The factors which differentiate the experimental conditions are the second - «positive difficulty»- [$F(2,223) = 12.04$, $p < .0001$], relative to the information, and the third - «negative difficulty»- [$F(5,220) = 1.89$, $p < .097$], relative to the information and the awareness.

The result of *LSD* test shows that the factor of «positive difficulty» of the task is perceived more highly under the condition «no availability» of the information ($m = -.42$) than under the conditions of «some availability» ($m = .27$) and «continuous availability» ($m = .17$), ($LSD = .69$, $p < .0001$ and $LSD = .59$, $p < .0001$, respectively).

The factor of «negative difficulty» of the task seems to be differentiated on the variable of awareness under the condition where the students have continuous access to the information ($m = -.14$, $m = .36$, $LSD = .49$, $p < .047$). The students who are awarded with the correct answer perceive the «negative difficulty» of the task more highly. Also, another difference is the availability of the information (some - continuous) when there is no awareness. The students under the condition of «some availability» ($m = -.15$) perceive the negative difficulty of the task more than the students under the condition of «continuous availability» of the information ($m = .36$), ($LSD = .51$, $p < .028$).

Image of the teachers

The two factors presented by the factorial

Table 3
Means of the characteristics of the image of the task (on a five-point scale) and results of the factorial analysis ($N = 225$)

Characteristics	*Means*	*F1*	*F2*	*F3*
1. Organized - Disorganized	2.46	**.53**	.15	**-.36**
2. Original - Trite	2.51	**.45**	**.55**	**-.38**
3. Difficult - Easy	2.79	-.13	**.57**	**.51**
4. Significant - Insignificant	2.67	**.69**	.26	.11
5. Comprehensible - Incomprehensible	2.63	**.58**	-.33	**-.35**
6. Familiar - Unknown	3.13	**.53**	**-.56**	.02
7. Creative - Non creative	2.62	**.76**	-.02	.14
8. Concrete - Abstract	2.41	**.67**	-.01	-.07
9. Ordinary - Unusual	3.60	.18	**-.65**	**.45**
10. Accessible - Inaccessible	2.85	**.68**	-.30	-.06
11. Substantive - Insubstantial	2.59	**.74**	.12	.20
12. Specialized - General	2.95	**.47**	.19	**.39**
13. Upgraded - Downgraded	2.47	**.73**	.15	.15
14. Logical - Illogical	2.26	**.71**	-.07	-.02
15. Interesting - Uninteresting	2.39	**.74**	.20	-.01
Total variance	56.1%	36.8%	11.9%	7.5%

analysis which was applied to the data of the image of the teachers interpret 52.7% of the total variance (Table 4). The first factor (45.3% of the total variance) concentrates on the following propositions: «promote dialogue during the class», «know how to engage interest in learning», «have a good teaching rhythm», «are attentive to weak students», «explain the lesson well», «grade fairly», «are polite», «are interested in your personal problems», «are calm», «are available outside class time», «teach good classes», «collaborate with the students», «use examples to explicate the lesson», «care whether you have understood the lesson». This factor covers the positive image of the teachers. The second factor (7.5% of the total variance) refers to an image of good communication between students and teachers, with the difference that the teachers are unfair in their grading. It concentrates on the following propositions: «promote dialogue during the class», «know how to engage interest in learning», «don't make distinctions among students», «do not grade fairly».

The factor which differentiates the experimental conditions is that of the positive image of the teachers [$F(5,230) = 8.06$, $p < .0001$], relative to information and awareness. For the individuals under the condition of «awareness», those who have some access to the information perceive the teachers more positively ($m = -.67$) than the individuals who have continuous access to the information ($m = .34$), ($LSD = 1.01$, $p < .0001$). Also, the individuals who don't have any access to the information ($m = -.11$) perceive the professors more positively than those who have continuous access to the information ($m = .34$), ($LSD = .45$, $p < .040$). Among those who are not awarded we see a more positive perception of the image of the teachers in the individuals who have continuous access to the information ($m = -.24$)

Table 4
Means of the propositions that constitute the image of teachers and factorial analysis (1 = Not at all, 5 = Absolutely) (*N* = 219)

Propositions	*Means*	*F1*	*F2*
1. Promote dialogue during class	3.51	**.60**	**.49**
2. Know how to engage interest in learning	3.35	**.71**	**.32**
3. Have a good teaching rhythm	3.47	**.79**	.04
4. Are attentive to weak students	3.28	**.67**	.10
5. Explain the lesson well	3.81	**.81**	.14
6. Grade fairly	3.32	**.55**	**-.46**
7. Are polite	3.76	**.71**	-.13
8. Don't make distinctions among students	3.31	.23	**.59**
9. Are interested in your personal problems	2.33	**.50**	-.03
10. Are calm	3.16	**.67**	.01
11. Are available outside class time	3.09	**.59**	-.17
12. Teach good classes	3.22	**.79**	-.04
13. Collaborate with the students	3.67	**.79**	-.09
14. Use examples to explicate the lesson	4.04	**.66**	-.25
15. Care whether you have understood the lesson	3.24	**.76**	-.20
Total variance	52.7%	45.3%	7.5%

than in those who have only partial access (m = .25), (LSD = .49, p < .022) and those who do not have any access at all (m = .41), (LSD = .65, p < .022). Under the conditions of «some availability» of the information and «no availability» of the information there is a differentiation as to the awareness. Those who are awarded with the correct answer to the problems (m = -.67 and m = -.11, respectively) perceive their teachers more positively than those who are not awarded (m = .25 and m = .41, respectively), (LSD = .93, p < .001 and LSD = .52, p < .011, respectively). Another difference regarding awareness concerns the condition «continuous availability» of the information. The individuals who are not awarded (m = -.24) perceive their teachers more positively than those who are awarded (m = .34), (LSD = .58, p < .011).

From the three images -of self, of the task and of the teachers- which were chosen to determine the way of conflict elaboration, differences emerge regarding the variable of information and the variable of awareness. The individuals who have access (some or continuous) to the information are reduced to a conflict situation. In an attempt to solve it, they overrate the positive self-image and underrate the positive difficulty of the task. Under the condition of «no availability» of the information the individuals perceive themselves less positively and overrate the positive difficulty of the task. Moreover, under this condition we observe the lowest percentage of correct answers. The conflict here is so intense, that it resolves itself, excluding any cognitive activity (Festinger, 1957; Poitou, 1974).

The variable of awareness differentiates individuals under the condition of «continuous availability» of the information. The students who are aware have an increased positive self-image (prepared), at the expense of the task (negative difficulty) and of the teachers (less positive image), compared to those who are not aware. The individuals who have continuous access to the information and are aware of the correct solution to the problems elaborate the ability conflict within the framework of preserving the positive self-image. The intense conflict is expected to lead the individuals under this condition to increased performances and to a generalization of knowledge in the post-test.

Post-test: Knowledge of the concept of «light-year» and its application to the solution of problems

Concept of «light-year»

The correct answers the students gave in the post-test regarding the concept of «light-year» are presented as follows: 57.1% in the condition «continuous availability» versus 36.9% in the condition «some availability» and 34,1% in the condition «no availability» (X^2 = 9,66, df = 2, p < .008). The increased percent of correct answers in the post-test is the result of processing the available and accessible information of the condition «continuous availability of the information». Under this condition the differentiating role of information appears concerning the percentages of answers to the concept «light-year» in the pre-test and the post-test in relation to information and awareness. In the condition where the students are awarded with the correct answers in the pre-test we see an increase in the correct answers to the concept «light-year» in the post-test (from 60.9% to 71.4%, X^2 = 5.25, p < .022). In the condition where they are not awarded the percentage of correct answers decreases significantly (from 62.9% to 42.9%, X^2 = 6.37, p < .012). As a result, the increased percentages of correct answers in the condition of «continuous availability» of the information (57.1%) are due to students who are awarded. That is, awareness strengthens the processing of the available and accessible information, which is not sufficient to produce generalized knowledge on its own.

Problems resolution

Table 5 presents the total percentages of answers in the first and second problem of the post-test. We observe that the percent of correct answers and justifications to the first problem is larger than it is to the second (17.7% versus 5.3%, X^2 = 107,55, df = 9, p < .0001 and 16.9% versus 5.3%, X^2 = 89.96, df = 9, p < .0001, respectively). These performances confirm the increasing difficulty of the problems in the post-test.

The distribution of «correct», «intermediate» and «incorrect» answers and justifications of the problems in relation to the information is seen in Table 6. In the post-test the largest percentage of correct answers and justifications for the first and the second problem relates to the condition of «continuous availability» of the information (31.5%, 21.5%, 11.3% and 12.85%).

The differentiating role of awareness appears in the condition of «continuous availability of the information» (Table 7). Specifically, the students who have continuous access to the information and are then awarded with the correct answer to the problems present an increase of correct answers and justifications for both problems in the post-test (from 11.4% to 40%, X^2 = 19.31, df = 9, p < .004, from 20% to 31.6%, X^2 = 22.41, df = 9, p < .008, from 11.4% to 14.3%, X^2 = 40.22, df = 9, p < .0001 and from 11.4% to 17.1%, X^2 = 39.03, df = 9, p < .0001, respectively). In contrast, students who have continuous access to the information but are not awarded with the correct solution either decrease the correct answers and justifications (from 28.6% to 23% and from 17% to 11.4%) or keep them stable (8.6%). Therefore, as with the knowledge of the concept of «light-year», so with its application to the solution of problems, the factor which leads to the production of new knowledge is the awareness of the correct answers on the

Table 5
Percentages of «correct», «intermediate» and «incorrect» answers and justifications of the total problems in the post-test (N = 243)

Problems		Post-test
Answers Problem 1	Correct	**17.7**
	Intermediate	28.8
	Incorrect	12.8
	No answer	40.7
Justifications Problem 1	Correct	**16.9**
	Intermediate	17.7
	Incorrect	9.9
	No answer	55.5
Answers Problem 2	Correct	**5.3**
	Intermediate	40.3
	Incorrect	14.4
	No answer	57.6
Justifications Problem 2	Correct	**5.3**
	Intermediate	31.3
	Incorrect	5.8
	No answer	57.6

Table 6
Percentages of «correct», «intermediate» and «incorrect» answers and justifications in relation to the information in the post-test (*N* = 243)

Problems		Continuous availability of the information	Some availability of the information	No availability of the information	X^2 $df = 6$
Answers Problem 1	Correct	**31.5**	**13.8**	**10.5**	30.23****
	Intermediate	22.9	34.5	27.9	
	Incorrect	5.7	16.1	25.6	
	No answer	40	46	36	
Justifications Problem 1	Correct	**21.5**	**16.15**	**14**	17.35***
	Intermediate	14.25	23.05	15.1	
	Incorrect	5.7	3.4	19.8	
	No answer	58.6	57.5	51.2	
Answers Problem 2	Correct	**11.3**	**3.5**	**2.35**	18.37**
	Intermediate	35.7	44.85	39.5	
	Incorrect	0	8	24.4	
	No answer	42.9	43.7	33.7	
Justifications Problem 2	Correct	**12.85**	**4.6**	**0**	19.31*
	Intermediate	24.3	32.25	36	
	Incorrect	8.6	1.1	8.1	
	No answer	54.3	62.1	55.8	

**** $p < .0001$, *** $p < .008$, ** $p < .005$, * $p < .004$

condition that there is available and accessible information that will boost its production.

Discussion and conclusion

The production of new, cohesive, generalized and assimilated knowledge is the result of the elaboration of conflict that is created when the individual is required to handle «difficult» (unfamiliar) concepts. It consists of an ability conflict implicating the identity of the subject. This form of conflict is defined by the representation of the subject itself, of the task and of the other. Within the framework of seeking confirmation of the subject's identity conflict is resolved by overrating the positive self-image, at the expense of the task and of the other (teachers).

According to our initial hypothesis, conflict emerges in the case of individuals who have access to the requisite information throughout the experimental process. The results show that individuals who have continuous access to the information in the pre-test overrate their positive self-image and underrate the positive difficulty of the task. In the post-test the correct answers regarding the concept of «light-year» and its application in the solution of problems are increased. This fact is indicative of the constructive elaboration of conflict and is confirmed by the decreased need of the subject to preserve the positive self-image. From the measurements of the post-test self-image under the same condition there emerges an increased perception of negative post-test self-image (less positive relative to the pre-test) and a decreased

Table 7
Percentages of answers relative to the solution of problems for each experimental condition in the pre-test and the post-test (*N* = 243)*

		Continuous availability Awareness				Some availability Awareness				No availability Awareness			
		YES		NO		YES		NO		YES		NO	
		Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
Answers	Correct	11.4	**40**	28.6	**23**	9.3	19	20	18	6.8	9.1	6.5	4.3
Problem 1	Intermed.	34.3	28.6	17	17.1	33	39.5	5	37.5	14	29.5	20	19.5
	Incorrect	40.3	8.6	45.8	2.9	11.2	2.3	40	33	47.4	9.1	21.3	20
	Nothing	14.3	23	8.6	57	46.5	40	35	12.5	31.8	52	52.2	57
Justif.	Correct	20	**31.4**	17	**11.4**	2.3	16.3	13	25	4.5	16	8.7	4
Problem 1	Intermed.	31.5	17.1	34	11.4	40	30.2	2.5	30.2	9.1	15.9	15	17.4
	Incorrect	26	11	29	0	9.3	2.3	43	2.3	34	4.5	24	20
	Nothing	26	40	20	63.6	49	51.2	43	51.2	52	63.6	52	58.7
Answers	Correct	11.4	**14.3**	8.6	**8.6**	0	4.7	2.5	2.5	0	2.3	2.2	2.2
Problem 2	Intermed.	34.3	31.4	60	40	53.5	44.2	30	37.5	47.7	45.5	37	41.3
	Incorrect	14.3	17	14.3	2.9	7	4.7	27.5	38	15.9	11	10.9	13
	Nothing	40	37	17.1	49	39.5	47	40	23	36.4	41	50	43
Justif.	Correct	11.4	**17.1**	8.6	**8.6**	0	4.7	2.5	0	0	4.5	2.2	0
Problem 2	Intermed.	31.4	28.6	60	20	48.8	23.3	37.5	27.5	50	40.9	32.6	43.5
	Incorrect	11.4	14.3	8.6	2.9	2.3	2.3	10	10	2.3	0	6.5	6.5
	Nothing	45.7	40	22.9	68.6	48.8	69.8	50	62.5	47.7	54.5	58.7	50

* The results of performance in the post-test are statistically significant for all experimental conditions:
Answer 1: $X^2 = 61.18$, $df = 15$, $p < .0001$, Justifications 1: $X^2 = 38.43$, $df = 15$, $p < .001$.
Answer 2: $X^2 = 35.23$, $df = 15$, $p < .002$, Justifications 2: $X^2 = 34.59$, $df = 15$, $p < .003$.

perception of irresponsibility. (The measurements of the post-test image of the task and the other do not present differences relative to the independent variables. The only factors differentiating the experimental conditions relative to the information in the post-test of self are: negative self-image and irresponsibility.)

In the condition of «continuous availability of the information» conflict is increased when the individuals are awarded with the correct answers, and with the boost of information (due to the awareness) its creative role emerges. The students under this condition in the pre-test perceive themselves as more prepared, they overrate the negative difficulty of the task and they perceive their teachers less positively. In the post-test a quantitative and qualitative increase appears in correct answers relating to both the concept of «light-year» and its constructive assimilation (generalization), as it emerges from the correct answers and justifications in the solution of similar problems.

In the attempt by the subjects to use an available and accessible piece of information in order to solve unfamiliar problems, thus proving their abilities, an increased socio-cognitive activity is produced. When they are awarded with the correct solutions to the problems, they have

an opportunity to evaluate their abilities. In discovering their mistakes, their socio-cognitive activity intensifies. Therefore, the awareness reinforces ability conflict and acts as an informational system of reference, giving feedback to the socio-cognitive activity of the subject.

A prerequisite condition to constructive elaboration of conflict in problem-solving tasks is the continuous access to information when it is accompanied by an awareness of the correct solution, which comes from a specialized-credible source (of high ability). Through converging thought, conflict leads to cohesive and assimilated knowledge, relative to the information suggested by the source. Information and awareness constitute the background of knowledge, guaranteed by the specialized source, within which the mechanisms of solution of conflict will be activated. Therefore, for the assimilation of new knowledge students must enter into a cognitive process which will allow them to articulate the new to the old, that is to reconstruct their knowledge. This will happen only when they have the necessary information that relates to the new piece of knowledge, practice with this information and have access to the control of their knowledge in order to validate it.

The present study showed the important role of the conflict and of the availability of information during the elaboration of a new, «difficult» concept. We can suppose that this role does not depend on the domain specificity, it does not concern a specific knowledge (the concept of «light-year») but the process of assimilation in general. Yet, future researches have to examine this role using experimental paradigms of other domains and controlling the conditions under which the «partial availability» of the information could possibly lead to a consistent system of knowledge.

These implications are very important regarding not only the way children construct their general knowledge but also the way the new special knowledge must be taught during the educational process in order to be efficient.

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