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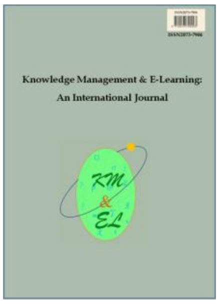

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Using concept maps to create reasoning models to teach thinking: An application for solving kinematics problems

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Abstract: We present research carried out with university students taking the subject "Concept Maps in Teaching" within the Master's Degree on Research in Teaching and Learning of the Experimental Sciences. The objective of this study was to elaborate a reasoning model, created using concept maps, that captures modes of thinking of expert teachers about solving kinematics problems. This model, used as a framework for those with less expertise in a particular form of argumentation, identifies approaches to solving certain types of problems. This paper focuses on the creation, utilisation, and validation of a reasoning model for solving kinematics problems. This model may apply to other types of learning content (concepts, procedures, but primarily arguments). The study was conducted during a school year with 60 students using a pre-test and post-test method to quantify the effectiveness of the reasoning model developed in problem solving. The statistical analysis revealed a statistically significant difference between the performance of the experimental and control groups. The results suggest that the development and use of this type of meta-reasoning, which is necessary for building a reasoning model, are of great help in teaching our students to reason about kinematics problem solving.

Keywords: Concept maps; Reasoning models; Physics education; Problem solving

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1. Introduction

1.1. From concept maps to reasoning models

A concept map is a graphical procedure to make explicit our knowledge of concepts and the relationships among them, in form of propositions. Concept maps are used to improve skills of the students, such as reasoning and problem-solving, and help students to understand concepts (Novak, Gowin, & Johansen, 1983). Concept maps are said to be a powerful tool that facilitate the analysis of certain content, making explicit its logical relationships and its levels of complexity for different purposes (Pérez, Suero, Montanero, & Montanero, 1998). Concept maps provide information about students' misconceptions, which may not be possible to identify using traditional tests (Rice, Ryan, & Samson, 1998). Thus, Concept maps may be used as an in-depth assessment tool in teaching Physics (İngeç, 2009). Recent studies (Martinez-Borreguero, Pérez-Rodríguez, Suero-López, & Pardo-Fernández, 2013) show that concept maps allow teachers to combat students' misconceptions.

One of the most highlighted uses of concept maps involves the capture of expert knowledge on a particular topic (Novak, 1990; Novak & Gowin, 1984). This allows for the creation of a "knowledge model", which is a collection of concept maps with linked resources about a particular topic (Novak & Cañas, 2006). The knowledge model may be presented to less experienced individuals as an example of one possible way to choose, rank, relate, and structure concepts and relationships among the components that make up a given body of knowledge. While building knowledge is a task that each person carries out on their own, this process may benefit from the assistance of others. Such collaborative learning allows others to propose relationships among concepts that each person may or may not adopt, depending on his or her own cognitive structure and on the compatibility of that structure with the new proposal.

Concept Maps have been used in many studies, even in those that are not specific to Concept Maps. For instance, in a study on the effectiveness of different simulation environments, Martínez, Naranjo, Pérez, Suero, and Pardo (2011) used concept maps to understand the reasoning of the students. Accordingly, many studies have been conducted in this area, and increasing numbers of researchers are attempting to create knowledge models with concept maps (Cañas et al., 2000; Martínez, Pérez, Suero, & Pardo, 2010, 2012, 2013; Nesbit & Olusola, 2006; Novak, 1998).

According to Novak and Gowin (1984), concept maps are graphical tools for organizing and representing knowledge. Because these knowledge representation tools must have a basic construction and specific characteristics (Cañas et al., 2003), not all graphs that contain text in their nodes are concept maps. Moreover, the literature is full of diagrams that are incorrectly portrayed as concept maps. Concept maps are two-dimensional, hierarchical, node-linked diagrams that represent conceptual knowledge in a concise visual form (Quinn, Mintzes, & Laws, 2004; Horton et al., 1993). Concept maps include concepts, defined by Novak as "a perceived regularity in events or objects, or records of events or objects". However, learning content is not only conceptual, such as facts, concepts, and principles. In addition, there also exists procedural and attitudinal content, and in the present study we move a step further. We believe that it is prudent to consider the process of reasoning as a type of procedural learning content. Authors such as Bao et al. (2009) noted that in most traditional educational settings, teaching and learning emphasize the training of conceptual content and it is often expected that consistent and rigorous content learning will help develop students' general reasoning abilities. Their study seeks to answer the question of whether and to what extent content learning may affect the development of general reasoning abilities. They conclude that teaching content knowledge often does not transfer to help students develop a good reasoning ability.

It is widely assumed that reasoning is something that can be done well or poorly, efficiently or inefficiently. You can learn to think and you can also teach to think: learning to think and teaching to think must be an important educational goal. The learning process involves many processes, such as memory, association, reasoning, etc., which produce what is called knowledge. Thus, we must not just teach a particular subject; the teaching process should seek to develop reasoning skills that foster learning in that subject.

For teaching reasoning skill, it would be helpful to call “reasoning maps” to the meaningful diagrams that express a reasoning strategy or process. The reasoning maps are structured, ranked and related in the same manner as novakian concept maps, but also try to capture and represent reasoning, for example when solving physics problems. These reasoning maps could be created by expert teachers, and be offered as example of strategy to others who are less experienced in the field. One example of reasoning map can be found on the section 1.3 of the present paper present paper.

1.2. From meta-cognition to meta-reasoning in physics problem solving

Problem solving may be considered one of the didactic foundations of any scientific discipline. For this reason, a great number of researchers have conducted studies on problem solving strategies in sciences (Solaz-Portolés, Sanjosé, & Gómez, 2011). Authors like Hsu, Brewe, Foster, and Harper (2004) consider the study of how students learn to solve problems as a subfield of physics education research (PER). Research in problem solving also extends beyond PER, with links to cognitive science, psychology, and education. It provides an opportunity for application of scientific knowledge. From a pedagogical perspective, problem solving may also be viewed as a tool for assessing student learning.

Problem solving strategy has been defined as well from others point of view. Some researchers (Polya, 1945) describe problem solving as a sequence of procedures that must be completed by the solver. Polya created a four-step process (description, planning, implementation and checking) to guide the student while using and creating various representations of a problem to help in solving it. This problem-solving strategy is the precursor of all later linear problem-solving strategies built to help students solve physics problems. Others (Jonassen, 2011) consider problem solving as a cognitive activity that involves the creation of mental representation. For Reif and Heller (1982) the process of solving a problem is divided into three stages (description, search for a solution, and assessing the solution). Each stage implies the construction of a new representation for the problem.

Bashirah and Sanjay-Rebello (2012) look into the factors that lead to the use of different strategies for solving problems in kinematics and work with the same representation. Kohl and Finkelstein (2008) propose that students’ decision to use a quantitative or qualitative problem solving approach may be triggered by the features intrinsic or presented in a representation. On the other hand, students’ perception of a task as being quantitative or qualitative may guide them in how they use the representation.

Ding, Reay, Lee, and Bao (2011) have designed and implemented problems that contain multiple concepts, largely separated in the teaching timeline to promote effective problem-solving skills among introductory students. These synthesis problems cannot be easily solved just invoking locally introduced formulas. They enclose each synthesis problem into a sequence with two preceding conceptually based multiple-choice questions. These concept questions share with the subsequent problem the same deep structure and serve as guided scaffolding to stimulate students’ consideration of fundamental concepts.

Sanjay-Rebello, Cui, Bennett, Zollman, and Ozimek (2007) presented a theoretical framework that describes the transfer of learning in problem solving. This framework differentiates between two types of transfer processes that, though not mutually exclusive, are different from each other. Horizontal transfer (which involves associations between a learner’s well-developed internal knowledge structure and the new information gathered by the learner) and Vertical transfer (which involves associations between various knowledge elements that lead to the creation of a new knowledge structure that is productive in the new situation).

Several physics education researchers have designed instructional approaches to enhance the problem-solving skills of students (Heller, Keith, & Anderson, 1992) and their conceptual understanding (McDermott, Shaffer, & Somers, 1994). In addition, several physics educators have reformed the structure of physics courses to promote better learning and problem-solving skills (Leonard, Dufresne, & Mestre, 1996). For example, Solaz-Portolés and Sanjosé (2007), analysed different cognitive variables that influence problem solving. In other studies (Eylon & Reif, 1984; Bagno & Eylon, 1997), the role of the solver's knowledge organization in problem solving was examined. When students were taught to organize their knowledge into hierarchical structures or to use concept maps, their ability to remember and to use this knowledge to solve problems was enhanced. Moreover, these students were able to transfer their knowledge-structuring skill to non-physics contexts. Other researchers (Sternberg, 1998) have also noted that it is necessary to conduct an adequate didactic approach toward cognitive and meta-cognitive abilities to learn how to learn. Furthermore, Gök and Sýlay (2010) conclude that students instructed in meta-cognitive strategies for problem solving obtain better results when solving problems. The aim of their study was to examine the effects of teaching of the problem solving strategies on the students' physics achievement, strategy level, attitude, and achievement motivation.

The term meta-cognition, or meta-cognitive knowledge, has been defined as the knowledge one has about the factors affecting cognitive activities, that is, knowing how one acquires knowledge (Flavell, 1979; Brown, 1978). Flavell (1979) distinguishes between knowledge of the subject, task and strategies and what he calls metacognitive experience. Flavell (1985) further developed this difference when he adopted the distinction proposed by Ryle (1949) between declarative knowledge (knowing what) and procedural knowledge (knowing how). In this line, existing works further note that meta-cognition requires knowing what one wants to obtain (objectives) and how to obtain it (self-regulation or strategy). A similar distinction was defined by Baker (1991), who noted two interrelated components of meta-cognition: knowledge and regulation of cognition. Brown (1978) stresses the importance of knowing what you know, know what you need to know and understand the usefulness of intervention strategies to acquire such knowledge.

This concept of meta-cognition is fundamental to problem solving (Mayer, 1998), and the development of these skills helps a student to form mental models of a problem and to choose the best strategy for solving it. In other studies (Greca & Moreira, 2002), it was concluded that students who obtain the best results in solving electricity problems are those who formed a mental map of the electromagnetic field. This mental map is similar to a map that an expert (someone with extensive knowledge in a particular field of study) would build. Concretely, these students built concept maps (Novak & Gowin, 1984) that comprise differentiated, related, and ranked concepts. D.P. Simon and H.A. Simon (1978) showed that there are differences between problem-solving strategies used by experts and by novices. Experienced and inexperienced problem solvers disagree in their organization of knowledge about physics concepts (Gök & Sýlay, 2010). Larkin and Reif (1979) suggest that experienced problem solvers store physics principles in memory as pieces of information that are connected and can be usefully applied together. On the other hand, inexperienced problem solvers must inefficiently access each principle or equation individually from memory. Due to this chunked nature of information, the cognitive load on an experienced problem solver's short-term memory is lower and they can dedicate more memory to the process of solving the problem (Sweller, 1988). For inexperienced problem solvers, accessing information in pieces places a higher cognitive load on short-term memory and can interfere with the problem solving process.

Other studies (McDermott & Larkin, 1978) noted that experts use diagrams containing the information most relevant to the solution when considering problems. In addition, it has been demonstrated (Champagne, Klopfer, & Anderson, 1980; Chi, Feltovich, & Glaser, 1981) that experts at solving physics problems are those who conduct an exhaustive and qualitative analysis of the problem and reflect on it using a planning and control scheme. Such meta-cognitive skills engender success in problem solving (Swanson, 1990). Using metacognitive skills allows us to obtain the information we need, to be aware of our steps in the process of solving problems and to evaluate the productivity of our own thinking (Tesouro, 2005). Lately, terms like "learning to learn" and "teaching to think" are being largely used. From the cognitive point of view, we may ask what is meant by "teaching to learn to think." Many authors have studied and classified the types of knowledge that science education and problem solving require (Ferguson-Hessler & De Jong, 1990; Solaz-Portolés & Sanjosé, 2009). Shavelson, Ruiz-Primo, and Wiley (2005) present an outline of the different types of knowledge required for students to achieve the objectives set in the teaching of science. This scheme includes declarative knowledge (knowing what: specific content like facts, definitions and descriptions), procedural knowledge (knowing how: creation and application of rules, steps, guides), schematic knowledge (knowing why: principles, conceptual representations, relations between concepts) and strategic knowledge (knowing when, where and how to apply our knowledge, strategies, heuristics, etc.).

Consistent with the above precedents, this study has evolved from the concept of meta-cognition to that of meta-reasoning. Meta-cognition (thinking about what we know or not know on a specific topic) can complement and complete the acquisition of some reasoning skills, producing a meta-reasoning activity (thinking on what strategies we may or may not follow to solve problems).

Reasoning skills could be convergent or divergent. Authors like Torres (2011) indicate that convergent reasoning is vertical, logical or concrete, in contrast to divergent reasoning, which is creative, imaginative or expansive. The term meta-reasoning can be defined as reasoning about the reasoning process and may explain the way one seeks reasoning to solve a particular problem. In this regard, we believe that meta-reasoning involves a reflection activity that seeks to know why and how we use reasoning, and to find out what strategies and skills should be used. When meta-reasoning is conducted by an expert to solve certain types of problem, the result may be offered as an example to other individuals less experienced in the task. Thus, such an endeavour may constitute a reasoning model. To capture this expert meta-reasoning in a structured and organised manner, concept maps have been used as a basic didactic tool. However, because these maps comprise reasoning procedures, they are termed reasoning maps here.

Fig. 1 shows a concept map about the meta-cognition and meta-reasoning processes in problem solving. This map is also available on the Cmaps website "Universidad de Extremadura (Spain) in the directory "Metareasoning".

1.3. Example of a reasoning model - Problem solving for the kinematics of uniformly accelerated-rectilinear motion

As an example of a reasoning model, we have developed with our university students a set of maps that captures the reasoning style of a professor who is an expert in solving kinematics problems of uniformly accelerated-rectilinear motion. These students were taking the subject “Concept Maps in Teaching” within the Master’s Degree on Research in Teaching and Learning of the Experimental Sciences. The elaboration of the reasoning model was carried out performing a collaborative reconstruction in several stages.

First, each one of our students, future secondary teachers, was asked to prepare individual reasoning maps about the best strategy involved in the process of solving a kinematics problem.

Secondly, they reviewed and proposed changes to the maps made by their classmates. The negotiation and exchange of maps took place directly in the classrooms. The teacher took the responsibility of synthesizing the proposals of amendments to each of the individual maps. The result of this stage was what we denominated “map in revision”.

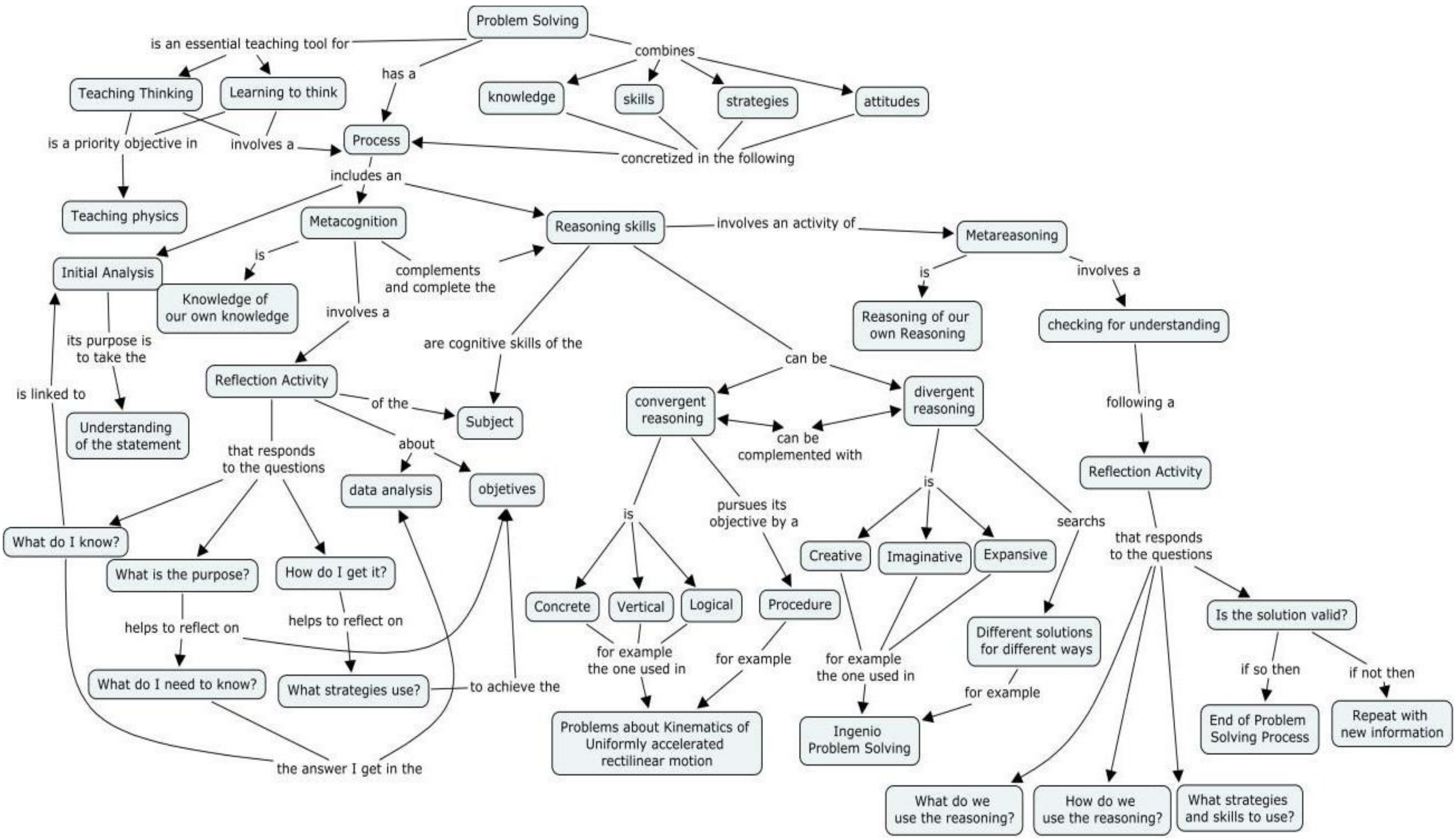

Fig. 1. Concept map about the meta-cognition and meta-reasoning processes in problem solving

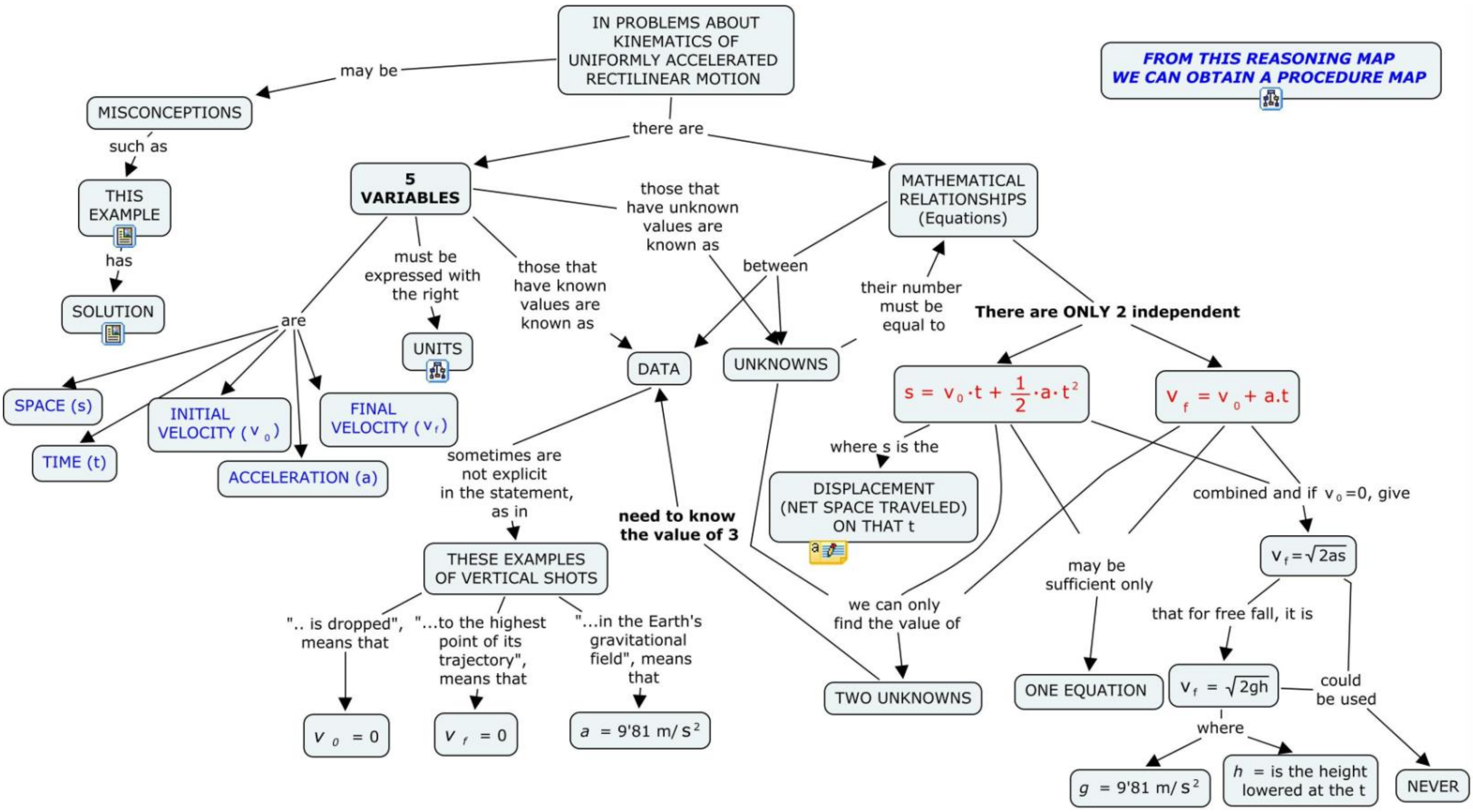

Fig. 2. Reasoning map capturing an expert professor's style of reasoning in solving kinematics problems of uniformly accelerated-rectilinear motion

Then, a discussion was performed to know if the students accepted or rejected the incorporation of the changes. The result of this process was each student's "revised map".

Finally, the teacher summarized the essential parts of all the revised maps in the "reasoning map".

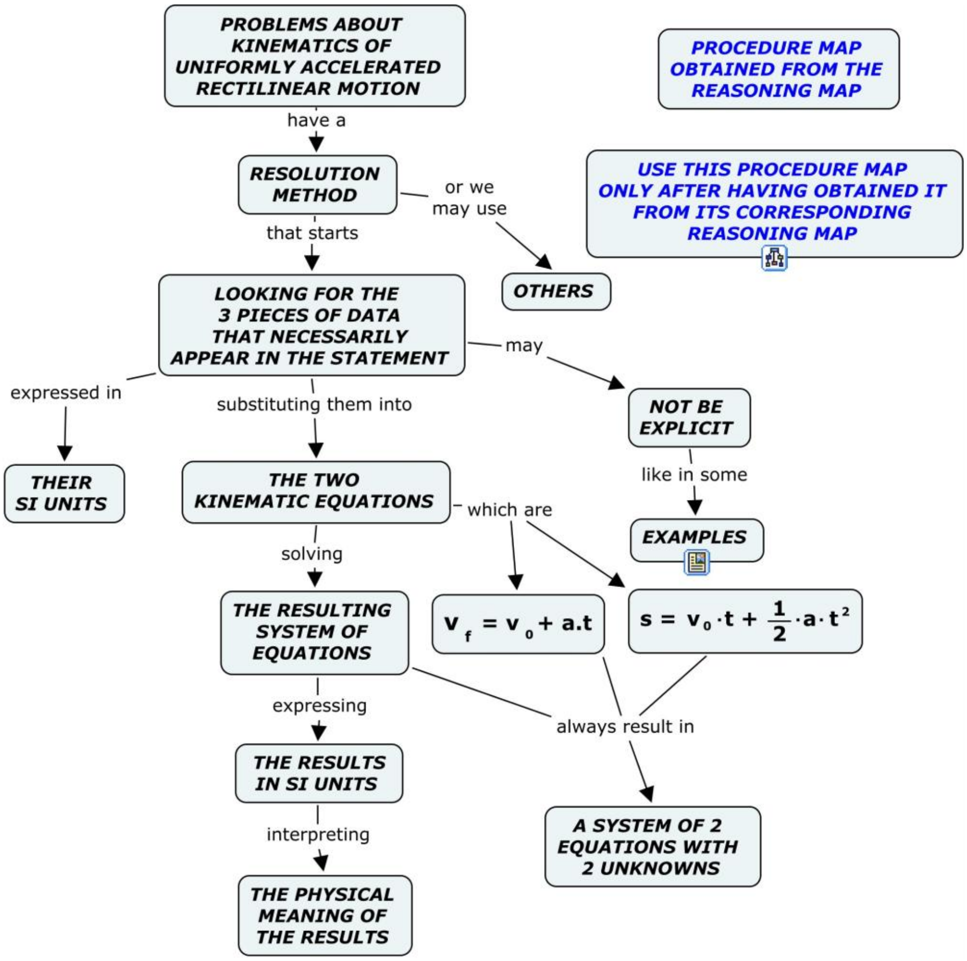

Fig. 3. Procedure map for solving kinematics problems of uniformly accelerated-rectilinear motion

Fig. 2 shows an example of the reasoning maps developed, capturing an expert professor's style of reasoning in solving kinematics problems of uniformly accelerated-rectilinear motion. From this reasoning map, and after many problems on the topic have been solved, one may obtain a procedure map, a diagram representing the steps to follow to solve all problems of this type, as can be seen on Fig. 3. The collection of the reasoning map and the procedure map establishes a simple reasoning model for solving kinematics problems of uniformly accelerated-rectilinear motion.

Fig. 2 and Fig. 3 use CmapTools (Cañas et al., 2003) to present this example of reasoning model carried out by our Master students. This model is available on the Cmap website "Universidad de Extremadura (Spain)" in the directory "Mapas de Experto" (Expert Maps); the maps can be used interactively through the CmapTools application (one may also view them by visiting the following link: http://tinyurl.com/expertmaps).

The procedure map depicted in Fig. 3 establishes that any kinematics problem of uniformly accelerated-rectilinear motion may be solved using the following steps:

1) Find the three variables of the problem, and express them in terms of S.I. units.

2) Substitute the three values into the two separate independent equations that govern this physical phenomenon.
3) Solve the two-equation system with two unknowns that appear in all instances, and express the results in the corresponding S.I. units.
4) Interpret the physical meaning of the results.

The exhaustive meta-reasoning process carried out to elaborate the reasoning map may result in the creation of a procedure map. The procedure map may be applied as an ad hoc protocol in order to avoid repeating the entire reasoning process that was used to originally establish the procedure. Once all nuances have been considered, the generated arguments may cover the entire gamut of possibilities, which makes developing new and different arguments from established arguments unnecessary (as occurs with the kinematics problems related to uniformly accelerated-rectilinear motion considered in this paper). Nevertheless, it remains necessary to clarify that the purpose of this model is not in any way to teach students to solve all types of problems mechanically. Rather, in using this procedure, once the student has already gone through a learning process, he or she will be able to recognise how a well-constructed meta-reasoning process may help him or her to understand the physical phenomenon in question and to significantly simplify the difficulty of problems that may be posed. Thus, the procedure map shown in Fig. 3 must be used only after having obtained it from its corresponding reasoning map shown in Fig. 2.

2. Methods

2.1. Objectives and study hypothesis

The general objective of this study is to develop a reasoning model that will help students solve physics problems more successfully. This general objective is further explicated by demonstrating the didactic effect that expert-created reasoning models have in solving kinematics problems of uniformly accelerated-rectilinear motion and identifying the amount of learning obtained by students who used these reasoning models. In addition, this didactic methodology is compared to a traditional model for problem solving.

The initial hypotheses proposed at the outset of the study are as follows:

Null Hypothesis (H0): There is no significant increase in the average performance attained by a group of students working with reasoning models compared to an equivalent group studying the same topic but without using reasoning models.

Alternative Hypothesis (H1): There is a significant increase in the average performance attained by a group of students working with reasoning models compared to an equivalent group studying the same topic but without using reasoning models.

2.2. Study design

A quasi-experimental design using a pre-test, a post-test, an experimental group and a control group was applied to examine the didactic efficacy of the reasoning models that have been developed. The independent variable considered here is the didactic method employed during the student learning process, which used reasoning models for the study of kinematics of uniformly accelerated-rectilinear movement (experimental group didactic method) or traditional didactic method based on textbooks, teacher lectures and example problem solving (control group didactic method). The dependent variable is the average increase of performance achieved by the students in the post-test relative to the pre-test.

Participants

The investigation was conducted during the 2012-2013 school year with data gathered from students in their 4th year in Secondary School (13-14 years old) in Spain. Specifically, the sample consisted of 60 students who attended the course in "Physics and Chemistry", who were already distributed into two 30 students groups.

Procedure

First all the students conducted a pre-test in order to know what they knew about the chosen topic and to check if the two groups were homogeneous and equivalent. As an assessment tool for the pre-test five sample problems on Kinematics of uniform rectilinear motion were chosen (similar to those found in textbooks of the subject "Physics and Chemistry" at their academic level). As a way of example, one of the questions used was "A ball is thrown upwards and it reaches eight meter high. What was the initial speed of the ball?" This pre-test showed that students had no initial knowledge about the content of Kinematics of uniform rectilinear motion, or knowledge of how to solve kinematics problems. This was expected, since this subject is not included in the 3rd year course in Secondary School, which was the last grade that had been passed by our students.

As the groups were homogenous and equivalent in the number of subjects, academic capacities, and academic performance in previous courses, one random group was designed as control group, and the other as experimental group.

The experiment was conducted with the same professor for the control and experimental groups, with the goal of minimizing the influence of the professor's didactic capacity as one possible confounding variable in the investigation. So as not to bias his performance with any group, he was not involved as a researcher in this paper. The professor in charge of conducting the experiment with the students conducted four one-hour sessions with each group of students. A meta-reasoning strategy was used in sessions with the experimental group by explaining the reasoning model that was used.

Specifically, two sessions were used for the explanation and discussion of the reasoning and procedural maps that make up the reasoning model presented. With the help of the CmapTools software, which allows presentations, the different propositions that form the maps were gradually exposed. The reasoning of each of these propositions was detailed and discussed with students in the experimental group. Thus, the basis behind the reasoning is made explicit, showing the reasoning of the teacher to arrive at the correct solution of the problems of kinematics. The other two sessions were devoted to solving standard problems, following the procedure established by the reasoning model.

However, the professor used traditional texts and resources with the control group to explain the content and the process of solving kinematics problems. Two of the four sessions were devoted to the explanation of the contents using the student textbook, and two other sessions were devoted to problem solving, following the multiple equations and formulae that appear in the book.

The evaluation instrument was the same for students in both study groups, and they were given the same amount of time to complete it, so that a comparative analysis could be conducted for the groups. Specifically, a questionnaire with ten traditional kinematic problems was created and given as a post-test to each study group at the end of the training.

The problems posed to the students in the post-test were similar to those from the pre-test. Specifically, they were also extracted from textbooks of the subject of physics and chemistry of the appropriate level, to make sure that both assessment instruments were equivalent.

As a way of example, one of the post-test questions used was “An object is thrown upwards and it reaches five meter high. What was the initial speed of the object?” As can be seen, it is basically the same problem from the pre-test but changing the numerical values of the statement.

3. Results and discussion

The average number of correct answers given by the control group was compared to the average number of correct answers provided by the experimental group. Table 1 presents the average number of correct answers, standard deviation, and standard error of the mean for each group. It is evident that there was a difference between the students who used the reasoning models (experimental group) and the students who did not use the reasoning models (control group).

Table 1
Descriptive statistical analysis of average number of correct answers obtained for each group

GROUPS	N	MEAN	STANDARD DEVIATION	STANDARD ERROR OF THE MEAN
Experimental	30	7.00	2.25	0.48
Control	30	4.45	2.67	0.41

Student t-test was used to analyse the difference in the scores between the two groups. The result from this test is shown in Table 2. In this table, the difference in the means between the control and experimental groups was 2.55 points with a standard error of 0.63 in favour of the experimental group. This result suggests an average 57% higher score over the control group. The two-tailed significance of the t-test was $p < 0.001$, indicating that it is possible to reject the null hypothesis (H0) as established in this study: “There is no significant increase in the average performance attained by a group of students working with reasoning models compared to an equivalent group studying the same topic but without using reasoning models.” The results were statistically and educationally significant given the effect-size coefficient obtained, $r = 0.464$.

Table 2
Student t-test for equality of means

LEVENE’S TEST		T-TEST FOR EQUALITY OF MEANS						
F	Sig.	T	g.l.	Sig. (two-tailed)	Difference of means	Standard error of the difference	95% confidence interval for difference	
							Lower	Higher
0.962	0.331	3.994	58	0.000	2.55	0.64	1.27	3.82

This result suggests that creating and using the reasoning model was of great help in teaching this sample of students how to reason. Accordingly, employing these models is particularly interesting in science classes, specifically, physics classes.

4. Conclusions

To Knowledge models are an effective tool for capturing expert knowledge that may be used later to build new knowledge for less experienced individuals (Moon, Hoffman, Novak, & Cañas, 2011). These knowledge models, which have been subjected to several studies (Cañas, et al., 2000; Martínez, Pérez, Suero, & Pardo, 2010, 2013; Nesbit & Olusola, 2006), are built only with conceptual content and are the result of intense meta-cognitive activity.

In this study, we have used maps (structured, ranked and related in the same manner as novakian concept maps) to express a reasoning strategy or process; consequently, these maps have been termed “reasoning maps.” Constructing this type of map implies an intense meta-reasoning activity, which may be carried out in the classroom with students to explain the reasoning that led the teacher to the construction of the reasoning map. This way, the students took part in the detailed explanation behind each of the propositions that form the map of the reasoning process that the teacher follows, thus constituting an educational intervention that may improve student learning. Using this reasoning map in the classroom as a teaching tool for learning involves exposing the reasoning of the teacher, and then rebuilding it collaboratively with the students group.

Results reported here indicate that performing meta-reasoning helped the students to reduce the difficulties associated with solving the types of problems in question, i.e., students who reasoned about the type of reasoning that they were using to solve a specific type of problem were more successful in solving more problems of the same type. This finding is in agreement with other researchers who state that meta-cognition is very helpful in problem solving (Mayer, 1998) and that meta-cognitive skills normally engender success in solving problems (Swanson, 1990).

For some researchers (Champagne, Klopfer, & Anderson, 1980; Chi, Feltovich, & Glaser, 1981), experts in solving physics problems are those who conduct an exhaustive and qualitative analysis of the problem and reflect on it using a planning and control scheme. Following this idea, we found that using the reasoning models created by experts helped the students to arrive at an understanding of a particular physics problem and generate a framework from that may be presented in solving problems of that specific type.

The results of this study and statistical analysis confirm that there is a significant increase in the average performance attained by a group of students working with reasoning models compared to an equivalent group studying the same topic but without using reasoning models. Specifically, the difference in the means between the control and experimental groups was 2.55 points in favour of the experimental group, which suggests an average 57% higher level of knowledge than the control group.

Therefore, reasoning models can be considered effective methods for helping students to learn how to reason. Reasoning models also help individuals identify the best arguments for a solution to proposed problems.

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