

The development of different types of procedural knowledge at schools

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Received: March 8, 2015

Accepted: May 10, 2015

ABSTRACT

Procedural knowledge is a type of knowledge which exists in different scientific fields and needs to adopt different methods for its improvement. The purpose of this research is examining suitable solutions to improve procedural knowledge at school. In order to achieve this aim, the study has been conducted descriptively and the analytical-documental method has been utilized. The research population includes all the local and foreign scientific sources such as books, journals, valid scientific websites on procedural knowledge and similar topics, and considering the limited population, all the sources have been examined. Findings of the study indicate that new procedures are needed to improve this kind of knowledge and also other methods such as playing, computer simulation, and use of task analysis can be implemented. Exact identification of procedural knowledge and adopting proper methods of teaching can improve the procedural knowledge at schools.

KEYWORDS: procedural knowledge, identifying plans, procedures, transfer procedural knowledge, improvement methods.

1. INTRODUCTION

Knowledge as a human production has always been the focus of attention, even defining and categorizing knowledge has always been important to human being. Variety of knowledge has been categorized differently in terms of different people and procedures. One of the most popular categorizations in this field is categorizing knowledge in cognitive psychology perspective. In cognitive psychology and information process perspective, there are three kind of knowledge. The first type is statement knowledge which is represented by statement. For example, a person who presents his knowledge of controlling parts of the car, as steer, gear, clutch, and brake and gas equipments has statement knowledge. The second type of knowledge is procedural one which is represented as productions and practical activities. For example a person who can practically drive, has a procedural knowledge. The third type of knowledge is the knowledge of mental images which is represented as mental images. For example, a person who imagines taking part in a Rally racing and is driving has mental image knowledge. Such a person images the events in his mind in a way that as if they are happening in reality [1].

Apart from the mentioned classifications, there are other classifications of knowledge. One of these classifications divides knowledge into procedural and conceptual knowledge. Conceptual knowledge must be defined as a type of knowledge about facts (in general) and principles [2]. Research on conceptual changes supports this concept experimentally:

- The conceptual knowledge of newcomers is often in the form of separate pieces and need to be integrated during learning.
- The conceptual knowledge of experts must be organized for better development.

There is a general agreement that the conceptual knowledge must be defined as knowledge of concepts. Recent studies believe that richness of communication is a characteristic of conceptual knowledge and improves by more increase in experience.

Procedural knowledge is a procedure of a series of steps and some activities are done to achieve the goal. Knowledge of the way of things work is often called procedural knowledge. Procedures (the way things work) are identified by using skills, strategies, products and internal actions. These procedures can be presented in the following forms (the same source):

- Algorithm: is a predefined sequence of actions, which leads to a successful response when done correctly.
- Possible actions which must be sequenced to solve a problem (like equation-solution steps): this knowledge is created and developed by practicing solving the problems.

Nowadays, many concepts of knowledge are placed in procedural knowledge field. However, unfortunately the teaching methodology of this type of knowledge is not much known in educational community and this causes the learners not to acquire this type of knowledge well. It has been observed that in procedural knowledge topics, the students merely have the statement knowledge of knowing the project steps and cannot put their acquired knowledge into the practice. This factor leads to temporary and surface learning of this type of knowledge. Now there is a serious need for implementing procedures to improve this condition, however, so far, only one study has been conducted in Iran in this issue by Moradi

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[3] that examines and analyzes the curriculum content of teacher training course concerning the procedural knowledge, suggesting ideal model of teaching and comparing it with existing teaching methodology of teacher training centers (Zanjan teacher training center). Few studies have also been done all over the world which have mainly focused on examining the procedural knowledge in mathematics (e.g., [4]), whereas procedural knowledge have different types and all its dimensions requires attention.

Considering that the current research is an applied one, if the educational system cares about this issue and utilizes the solutions of this research and similar studies, it is hoped that our learners acquire the procedural knowledge effectively so that to assist the country in practical and industrial developments.

2. Research objectives

- Examining different types of procedural knowledge according to information process theory.
- Introducing the necessary steps for teaching procedural topics.
- Examining other useful methods that can help improve procedural knowledge in students.

3. Questions

- A. What are different types of procedural knowledge according to information processing theory?
- B. What stages are suitable for teaching procedural topics?
- C. What are other useful methods that can help students improve their procedural knowledge?

4. RESEARCH METHODOLOGY

In order to achieve the mentioned goals and answer the research questions, the current study is done as a descriptive one and analytical-documental method was used. The research population includes all local and foreign scientific sources such as books, journals, and valid scientific websites on procedural knowledge and similar topics, concerning the research keywords, however due to limitation of the sample and the conducted studies in this area, all sources have been examined.

5. Findings

Research questions are examined one by one in this section.

5.1. What are different types of procedural knowledge according to information processing theory?

Procedural knowledge in information process psychology perspective is categorized into three types of procedural knowledge of pattern recognition, Acquiring action-sequence procedures, and transfer procedural knowledge [4]. Each of these types of knowledge is examined briefly here.

❖ Pattern recognition: in this type of knowledge the person must be able to identify and classify different external and mental patterns and is almost equal to knowledge from concepts and classifications. The stages of this type of knowledge are often abstract [5].

❖ Acquiring action-sequence procedures: is related to a series of stages and activities according to symbols and algorithms. This knowledge is divided into three stages as following [6]:

- Procedural knowledge: in this stage the statement knowledge is changed into products step by step. For example, a new driver who states the stages of starting a car orally and then displays each stage in practice is an example of this stage [7].
- Combining: in this stage the learner has to combine and relate in a coherent pattern, several procedures which he has learned previously and are related to the new procedures. For example, a new driving learner has already learned the related activities about driving in daytime, night time, uphill and slopes. In this stage, it is necessary to combine all these procedures coherently, in a way that in a specific situation, the learner be able to identify the necessary procedure for that situation and activate the procedure from among coherent procedures [5].
- Automation: in this stage, the person is able to do the activity exactly and automatically and does not need to spend time on thinking about the stages. For example, consider a driver who drives well and automatically without a need to think of his driving [8].

❖ Transfer procedural knowledge: in this type of comprehensive knowledge, we get to know a series of principles about the image of the activity and in future will show different reactions in various situations, according to those principles. A clear example of this type of knowledge is teaching skills. At first, student-teachers get familiar with a series of principles and different teaching methodologies and in future will teach in different methods in various situations. In fact, the form of transfer procedural knowledge is not linear and algorithmic and each time the image of the components changes.

5.2. What stages are suitable for teaching procedural topics?

Moradi [3] has suggested the pattern of teaching different procedural knowledge (patter recognition, sequencing procedures and transfer) in the form of concrete stages. Following the teaching stages for each of the procedural knowledge are examined.

5.2.1. The teaching procedures of Procedural Knowledge (recognizing design)

□ Attracting attention and creating motivation: creating motivation is possible through using different methods including playing a video or telling a story by the teacher and other methods [9]. One of the best ways to generate interest in learning is paying attention to real and reversionary situations of learners' life. What is meant by reversionary situations are situations that students tend to attaining them in the future [10]. Other methods that can be used to create interest and motivation is teachers' attention to physical and mental readiness of learners to attain their educational purposes; Because if students do not have the necessary willingness to do something get disappointed toward it and do not have a lot of intrinsic motivation to learn [11].

□ Pervasive informing of education goals: At this stage it is necessary to inform the learners about the education goals and the point that we will get in after the training, so that not to be confused and continue to learn with a better planning [12]. For this purpose, teacher can express the learning purposes orally and in e-training at the beginning of the work, a part be developed with this title.

□ Recalling past learning: In this section it is necessary to link the former cognitive structures of the learners with the new teaching, activate the former learning related to the subject. For this purpose short questions can be used [13]. For example, a teacher who wants to teach Captivate software to his students can ask whether they have worked with the flash outputs. Then the teacher can say that Captivate software, is software to produce various multimedia formats, including Flash.

□ Generalization: providing continuous examples of the topic helps in making accurate generalizations about the discussed concepts in procedural knowledge. Generalization in procedural knowledge of the design means to classify the concepts in categories using similarity of the concepts with components of that category [3].

□ Discrimination: providing non-examples of a subject can help learners to discriminate. For example after the fish category is discussed dolphin can be discussed as a non-example of fish category. Non- example lacks at least one key feature of the desired category [2].

□ Using design in new cases: at this stage the learnt concept can be used in new cases.

□ Evaluation: At this stage of the learning process evaluation can be done. But assessment does not only take place at the end but it is used in the whole teaching process. It is better to consider the assessment as part the learning process, because this look is to assessment can be improving [14].

5.2.2. Stages of teaching procedural knowledge, operation stages

Three stages of teaching the procedural knowledge are kinds of stages like procedural knowledge of recognizing the design that is one of the general stages of teaching. It should be noted that these procedures be respected in both verbal training and e-training.

- Attracting attention and creating motivation
- informing the learner of the pervasive education goals
- Recalling former learning
- Recitative presentation of processes of procedural knowledge by the teacher: at this stage the teacher explains the learning process for the learners. In e-training or even in verbal training a text, video or speech that expresses the process can be used.
- Performing or presenting the stages by the teacher: at this stage the teacher explains the learning process himself or uses multimedia to expresses the process to the learners.
- Procedural method: at this stage, learners with teacher's guidance and feedback show their recitative knowledge step by step.
- Combination: at this stage learners with teacher's help link different things that they have learnt about the subject in a coherent and interconnected cognitive construction, and it takes place with practice, rehearsing and teacher's corrective feedback. Finally, doing those stages and that work becomes automatic for the learners and learners without much thought about the work do it well.
- Assigning task: at this stage the teacher gives his students a task to do. This stage can be intermingled with the evaluation process. Or it is possible first to evaluate students' learning on their performance and then ask them to do a task for the next session.
- Evaluation: As already mentioned, evaluation is not only at the end of the process, and a genuine assessment and evaluation is one that monitors the entire process and uses different tools to identify different aspects of learning. The actual assessment should be part of the learning process, and its role is to promote learning, not only to determine the amount of learning. If this type of assessment in different systems' evaluation be considered as quantitative, qualitative and consolidated, can contribute to the improvement of education.

5.2.3. Teaching stages of transfer

- attracting attention and creating motivation
- informing learner of the education goals
- recalling previous learning
- Presenting and teaching the principles of transfer in a simple position: the teacher based on the transfer work in a simple position provides simples principles and processes.
- Practicing the same principles in a simple position by the learners
- Presenting training and principles in a situation where the complexity is increased gradually.
- Practice the same principles by learners
- Final evaluation

5.3. What are the other useful techniques that can help improve students' procedural knowledge?

□ Using simulations and games: simulation is the metaphor of real behavior in an unreal position. The use of simulators are, such as flight simulator for pilot training, simulator of surgery room and other simulation; As well as educational computer games in an attractive environment can teach different procedural knowledge things directly or indirectly to the learners, and can be effective for creating procedural knowledge [15].

□ Using task analysis and drawing flowchart: some of the procedures are linear and it is necessary to arrange a series of fixed steps and run in tandem, such as how to open a car tire to fix its' punctured tire. In such cases for instructional design and even implementation of the work flowchart can be drawn so that none of the steps remain ambiguous [16]. Of course steps are very clear to the teacher and do not need any explanation, but the learner has some problems in some of the steps and this problem causes failure in learning the procedures. For example, in teaching children to brush their teeth in the First grade of elementary school, the teacher might say that brush your right upper jaw, but perhaps students do not know how to take the toothbrush in their hands that or how to pour toothpaste on the toothbrush and, but drawing Flowchart and analytical look at the latest linear procedures and some of the parallel topics can be effective in better training.

□ Using the desired behavioral approaches such as continuum making of behavior: behaviorism is one of the psychological approaches that believes that to create different behaviors and learning, a variety of different ways such as practice and repetition, encouragement, discipline (not corporal punishment), shaping the behavior, chain making the behavior, etc. can be used. For example, the chain making is so that forming components of a complex of behavior are divided into small and teachable behaviors and the order of the steps are determined and then the first stage of behavior with different treatment methods of behaviorism, such as reinforcement, practicing and rehearsing is formed and then to chain making the second stage behavior, first and second phases are taken together and reinforcement happens at this stage in a condition that both first and the second stage are performed correctly. Finally, the final reinforcement is presented for the learner if he does all the steps properly. This kind of learning is used mostly in procedural subjects and in transferring subjects these kinds cannot be used.

□ Promoting creativity to help different types of procedural knowledge and especially the transitional procedural knowledge can be very useful [17]. Some ways to promote creativity in schools include:

- Not limiting the students' activities of in some circumstances [18].
- Using new techniques and ideas in teaching [19].
- Considering individual differences in creative behaviors [20].
- Encouraging students to do things in a new and creative way [21].
- Making children sensitive to their environment [22].
- Respecting children's points of views [23].
- Considering creative environments in organizations like schools [24].
- Respecting the value of children's creative thinking [25].
- Considering adequate rest period in school programs [17].
- Encouraging creative children to make constructive criticisms [26].
- and ...

□ Encouraging learners to perform a similar activity in a variety of ways: this helps combination and automation and allows the learners to practice through the shortest and the best possible way. For example, there are different approaches and strategies to solve a math problem that the teachers are better to welcome all these strategies to build a coherent understanding of the different procedures. This is very useful, especially in transition procedures [4].

□ Using different strategies to solve problems and procedures related to mathematics that some of these strategies include [27]:

- Removing the undesirable condition. In this method the students will be able to get the answer through the gradual elimination of undesirable conditions.
- Solving the easier problem and relevant to the main question: In this method the students can change the problem into an easier form and solve it easily.
- Sub problem: Converting a complex problem into several smaller and simpler problems, so that by solving small problems, the main problem can be solved.
- Drawing the figure: In this method the students solve the problem through drawing a figure.
- Guessing and testing: The students can get the right answer through guessing and testing the correctness of their guesses and finally correcting their guesses through logical reasons.
- Systematic table: In this strategy, the student enters the data in a table in a logical order, so that all states of the problem are displayed in a systematic table.
- Pattern-finding: In this method, the answer becomes clear through finding a numeric or geometric relationship between the data of the problem.
- Algebraic Methods: In this method, we use algebraic equations to solve the complex problems.

6. DISCUSSION AND CONCLUSION

Knowledge has been divided into various forms according to the experts. From among these classifications, we can refer to the classification of knowledge in terms of cognitive psychology approach. Based on this approach, knowledge is in three forms of expression, procedure and mental images. Procedural knowledge itself is in three forms of procedural knowledge to identify the plan, procedural knowledge of action (the procedure, composition and automation) and transitive procedural knowledge. To teach any of a variety of procedural knowledge, specific methods and procedures are recommended and it requires the correct identification of existing knowledge in the first stage and then adoption of the appropriate teaching method to the kind of knowledge. In some cases, knowledge can be eclectic and for example, can be procedural and recognition as well that in such cases using a combination of methods intelligently can help to create an effective learning [28]. In addition to the concrete patterns offered for teaching a variety of procedural subjects, other ways, such as simulations, computer and traditional training games, using algorithms, present methods of behavioral approaches such as the continuum making of behavior, promote creativity, the use of different methods to solve problems and doing things, using different strategies to solve math problems and other innovative methods can be used. Hoping that with higher attention of the authorities in the educational system of the country to this sensitive topic, provide the social growth and progress of the society in procedural topics. In this regard the following recommendations are given to all operators of the country's education system:

- More attention to procedural issues and taking appropriate approaches for the development of this kind of knowledge through taking advantage of the results of this study and other similar studies
- Providing an instructional design model for, instructional designing of different types of procedural knowledge
- Conducting more research on the subject with other methods like quantitative research methods

In conclusion, it should be noted that according to the methodology used in this study (documental- analytical methods), there were no restrictions in this study and the only restriction in the course of the study was the access to the articles indexed in the Science Direct website and this problem was fortunately solved later.

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