A Comparison between Heuristic Teaching and Metacognitive Teaching Methods Regarding Students’ Educational Achievement

1Sakineh Bagheripebdani and 2LeilaBagheripebdani

1M.A. Public Management&Teacher of Sama Technical and Vocational Training College, Islamic Azad University MasjedSoleyman Branch, MasjedSoleyman.
2M.A. Educational Management, Islamic azad University, Shahrekord Branch, Shahrekord, Iran.

ABSTRACT

This study examined the effect of heuristic teaching method on Masjed Suleiman fourth primary school empirical sciences students’ achievement between 2012 and 2013, as compared to metacognitive teaching method. This quasi-experimental research was carried out on two groups. A group was taught by heuristic approach and another by metacognitive approach. Research design was implemented using pretest and posttest. The study sample consisted of Masjed Suleiman fourth primary school boys students studying between 2012 and 2013. The students were randomly clustered. First, a school was selected among Masjed Suleiman primary boy schools. Among fourth grade classrooms, one was taught by heuristic approach and another by metacognitive approach. There were thirty students in each classroom (total sample size 60). A validated pretest was administered for both groups. Then, they were taught for fifteen sessions. Finally, posttest was administered for each group. Results were analyzed using descriptive and inferential (independent T-test) statistics. Data was collected using a validated questionnaire consisting of forty-four-choice questions from the last five lessons of book ‘empirical sciences’. Test validity was approved by Masjed Suleiman primary school teachers. Its reliability is 0.77. Results indicate that there is significant difference between students taught by heuristic method and the students taught by metacognitive method regarding their mean educational achievement. This mean educational achievement is higher in heuristic method.

INTRODUCTION

Today, teaching methods are considered to be among the teachers’ challenges in the field of education and teaching learners. Applying the teaching method appropriate for each material is of critical significance. One of the methods of promoting teaching process quality is to improve teaching and instructional design methods. Education scholars have theorized by explaining how learning happens. Based on these theories, instructional designers design teaching and formulate teaching and testing methods fitted learning theories. In education literature, various definitions are presented regarding teaching methods. Some of them are implied, here: Teaching method refers to regular, rule-based, and rational way to present materials [10]. Teaching includes the interaction or mutual teacher–learner behavior based on the teacher’s organized and purposeful goal to change learners’ behavior. Teaching method comprises teacher’s policies ranging from goal setting to the end of assessment and declaration of results, observing the students’ reactions. Teacher interacts with learner in his teaching process [5]. The main principle in teaching process is organizing the settings for students’ interaction and examining how they learn. Teaching patterns describe learning environment. Patterns are students’ learning tools. They are applied to develop curricula. These patterns are not too much complicated. In the past, if someone wanted to learn something, he became apprenticed to a person having his desirable technique, knowledge, or skill. Industrial revolution changed the trend. A new pattern emerged based on which master could gather all learners in a place and present standardized curriculum to them. This education pattern was developed in 1800s and became prevalent in most years of 20th century. It was known as factory pattern extracted from sociology, trade, and religion fields. In this pattern, useful techniques like obedience, order, unification, and respect for authority were emphasized [4].

Heuristic method is defined as a teaching and learning method where student individually discovers the relationships between phenomena or produces new thought and (or) concept orelimines and studies a problem with and (or) without teacher’s special and limited guidance and make conclusion based on information...
obtained. He tries to get a general inference [1]. In this method, teaching conditions are provided so that students can discover some scientific concepts and principles via their mental activities and self-leadership. Among the qualities of this method, the followings can be implied: 1- Teaching and learning process via discussion and question-answer. 2- Teacher begins the instruction by posing a question, puzzle, and (or) a problem, and asks the students to answer or solve the problem. 3- Unlike ordinary methods, teacher plays the role of a guide, here. 4- Teacher does not consider a short (yes/no) answer to be enough and asks the students to elaborate further. 5- During teaching-learning process, teacher makes attempt to encourage his students to express their thoughts and curiosities, and test their theories. Yet, he neither judges the truth or falsity of their views nor interferes in them. 6- Teacher always makes attempt to direct the students toward data collection and discovering the answer via providing guidance and appropriate answers.

Heuristic teaching pattern was formulated in 1962 based on Sachman’s belief. This method emphasizes that individuals are naturally encouraged to explore. Students face wonderful situation and explore it. Since the final goal of learning is to drive the learners to experience, create and understand anew, learning process must be based on discoverable ideas. This pattern is a plan for teaching and reinforcing causal inference to the student. Methods like metacognitive and heuristic teaching are known as active teaching methods. In these methods, learning activity is carried out by means of learner and teacher is a guide. The general objective of heuristic method is to help the students to construct mental order and skills required for posing question and curiousness about the subject within themselves [7]. Among the objectives of finding answer for question and heuristic teaching include encouraging the students toward new experiences and production of new knowledge. Heuristic method is basically a student-centered activity. In this method, opportunities provided for teaching must be so as to provide basic students’ astonishment and imbalance and instructional activities basis. Teacher and students action-reaction is intimate and participatory. Any type of idea and (or) belief is worth, here. Although this structure may seem to be a bit complex, teaching-learning process is effective and encouraging. Heuristic method has emanated from scientific research methods. That is, like researchers, students face a problem in practice, collect data, organized and classify it, and hypothesize based on the information. Then, they test their hypotheses and finally make conclusion. Results are used for analyzing similar events.

Unlike direct instruction, teacher does not transfer and provide materials in heuristic method. Rather, he plays the role of a guide in teaching process. That is, he teaches the learners how to obtain information. The most important role of the teacher is to provide exploration opportunities, promote exploration spirit in the students, and direct their activities. At the same time, students are not the sole receptors. Rather, they seek for information and solve problem volitionally. The teacher is not the only source of information. Course book is not considered to be the only means of instruction.

In this method, library, laboratory, video, and museum all can be the source of receiving information. Instructional environment is not limited to school rather teaching can take place everywhere. Although heuristic method is more applicable for sciences course, it can be applied to all educational areas. Any subject which can produce an ambiguous situation will be appropriate for heuristic teaching. All people are naturally encouraged to explore. If students face a vague and challenging situation, they will dig into it. Any mysterious, unexpected or unknown thing – as an incongruous event - will be suitable for exploration [8].

**Heuristic Method Stages:**

**Stage 1:** Designing and selecting a problematic or mysterious situation: This is a situation creating cognitive imbalance in students and provokes them. To provide a mysterious scene, teacher must design and select this situation before instruction. He should tell the students what they expect them to do and which activities they must do, early in instruction. The more accurate the basic design is, the better the exploration will be.

**Stage 2:** Presenting mysterious situation: In this stage, mysterious situation is provided for the students. Teacher should do this in a way to further attract the students’ attention and provoke them.

**Stage 3:** Data collection and analysis and discovering relationships, concepts, and scientific principles: After presenting the mysterious situation, students discovers by searching, and collecting and analyzing data. Here, teacher must accept all solutions proposed by students, respect their thought and thinking, and encourage them to communicate thoughts. Students’ correct and incorrect answers must be of the same worth for the teacher. This is because they are resulted from thinking. Yet, teacher must lead the students to document their beliefs and thoughts by posing successive questions.

**Stage 4:** Rethinking and analyzing exploration process: In this stage, students fulfill activities by teacher’s help leading to their thinking processes’ analysis. To do so, the teacher can ask the students to rethink and review mystery and their thinking stages during exploration process. For instance, he can ask the students: when did you come up with clear explanations? How it happens? Teacher must provide the students with positive feedback to internally reinforce their heuristic behavior. For kids, principles and concepts must be directly presented and directed exploration must be used. This is because they have not so much experience and patience for non-directed heuristic method [1].
**Metacognitive Teaching Method:**

Generally, thinking’s metacognition is about thinking. The idea that learners think about their thinking goes back to Plato and Aristotle’s era. Yet, the term ‘metacognition’ was first entered into the field of cognitive psychology by John Flavel in 1976. He stated that: “Metacognition is the individual’s knowledge regarding his cognitive processes and products or anything related to them including characteristics related to learning information or data.”

Flavel has defined metacognition as the awareness of how an individual learns, how he used existing information to accomplish a goal, his ability to judge cognitive processes in a certain assignments, what strategies he uses for which objectives, his evaluation of his progress during and after activity.

The term ‘metacognition’ refers to the knowledge of cognitive processes and how to optimally use them for accomplishing learning objectives [3]. Metacognitive processes consist of two independent yet interrelated aspects: one is metacognitive knowledge and another is metacognitive experience [13]. Most theoreticians have distinguished between two aspects metacognition; that is, metacognitive beliefs and metacognitive monitoring. Metacognitive knowledge includes individuals’ information about their cognition and learning strategies. These strategies affect them. Metacognitive monitoring refers to a range of executive functions such as attention, control, planning, and error detection in performance [15].

The simplest definition of metacognition is thinking about thinking, awareness of what we know, and what we do not know, and one’s own cognition, knowledge and awareness. As an executive in organization is responsible for managing the organization, an individual is required to manage his own thinking and thought [16]. Hip and Bizar defined metacognition as a process where an individual accurately expresses his thinking in problem-solving situations by his planning, monitoring, self-organization, self-inquiry, and self-reflection or self-review strategies. McKeachie also pointed that metacognition is thinking about individual’s learning and thinking. On the other hand, metacognitive strategies are instructional strategies allowing the learner to use his metacognition in problem solving. Metacognition is also applied as human’s identification and knowledge concerning his cognitive processes and products. Metacognitive view refers to human cognition and awareness regarding his knowledge and awareness. Three following components are considered to be the main features of metacognition: explanatory knowledge (which deals with facts and information), procedural knowledge (which consists of operations and activities fulfilled to do a task; that is, how to know), and contextual and background knowledge (which deals with knowing whys in a context and ground) [1]. According to Favel (1976), metacognition refers to an individual’s knowledge regarding his cognitive processes and products and their respective issues. Metacognitive teaching method – one of the modern teaching methods applied in educational system – means human’s knowledge and identification concerning his cognitive processes and products. To put it in more simple words, metacognitive view is defined as identifying human’s awareness of his knowledge and awareness. Three following components are considered to be the main features of metacognition: explanatory knowledge (which deals with facts and information), procedural knowledge (which consists of operations and activities fulfilled to do a task; that is, how to know), and contextual and background knowledge (which deals with knowing whys in a context and ground). On the other hand, metacognition includes planning, directing, monitoring, and reforming cognitive processes and activities. The simplest meaning for metacognition is knowing knowledge or knowing about knowledge. A comparison between cognition and metacognition will provide better understanding. Generally, cognition means knowing. It includes high mental processes like problem solving, creativity, understanding, inducting, bridging, and inferring. Yet, metacognition is the knowledge of all cognitive processes. Metacognitive knowledge together with metacognitive experiences carries out directing, controlling, monitoring, and reforming cognitive processes and activities.

Metacognition refers to individual’s knowledge regarding his cognitive processes, action process, organization, and coordination of a set of trends and also any kind of cognitive knowledge or action concerning cognition or cognition organization. According to Krass and Paris (1988), metacognition refers to students’ knowledge and skill concerning their mental and learning activities. It is a multidimensional concept. This concept embraces knowledge, processes, and strategies evaluating, monitoring, and (or) controlling cognition [15]. According to Flavel (1979), metacognitive knowledge includes individuals’ information concerning their own cognition and learning strategies. These strategies affect them. Metacognitive monitoring refers to a range of executive functions such as attention, control, planning, and error detection in performance [15].

Concerning data processing, metacognition includes executive control processes (such as attention, review and practice, organization, and manipulation of information). The extent to which these are used leads to interpersonal differences in learning and remembering. On the other hand, the stronger a person is in executive control, the better the information will be processed in his memory. Metacognition is the individual’s awareness of his thinking when fulfilling assignments and tasks and the use of this awareness in controlling what he does. It implies planning, monitoring, and evaluating his cognitive assignments and tasks (memorizing, learning, problem solving, studying, reading, listening, decision making, and comprehending) and judging the effective fulfillment of these assignments [16]. Perner believes that metacognitive strategies can be taught to the students so that they can use them properly and enhance their learning level.
Metacognitive Teaching Stages:

**Stage 1:** Diagnostic evaluation and awareness of background knowledge: Two following steps are practiced, here.

- **Step 1:** Before beginning the new lesson, teacher or instructor must know students’ background knowledge. That is, he must determine their mental vigor degree.
- **Step 2:** Determining the starting point of teaching: Teaching and learning process gets started from learners’ present knowledge.

**Stage 2:** Planning stage: This stage is realized by four steps, below:

- **Step 1:** Establishing commitment (selecting affairs based on student’s will): Teacher or instructor must provide necessary opportunity for students to make a volitional choice.
- **Step 2:** Creating this mindset that human can capture and learn everything by making conscious attempt.
- **Step 3:** Paying volitional and voluntary attention to affairs.
- **Step 4:** Teach or instructor must specify and classify the kinds of knowledge learners must learn including explanatory knowledge (what should he learn?), procedural knowledge (how should he learn?), and contextual knowledge (why should he learn?).

**Stage 3:** Self-regulation in learning, continuous and step-wise control, and progress toward objectives by students: In this stage, following steps are practiced: First step: Teacher or instructor plays the role of mental scaffold so as to help the students with beginning themselves. Second step: Teacher must provide the student with opportunity to observe affairs. Third step: Teacher or instructor must help the student and provide him with opportunities to judge.

**Stage 4:** Permanent control in learning based on the actualization of objectives and revising self-regulation: It requires two steps below: First step: Learning control by the student based on the extent of objectives realization. Second step: Revising processes and activities for the absolute realization of objectives [1].

Cognitive Strategies versus Metacognitive Strategies:

Dehghani [6] believes that metacognitive strategies act in relation to cognitive strategies. If a person does not know how to use cognitive skills, he cannot successfully plan, monitor, and self-organize. Hence, cognitive and metacognitive strategies work together. Yet, we can make a slight distinction between cognitive and metacognitive strategies. While cognitive strategies are necessary tools for learning content, metacognitive strategies provide monitoring and directing for the use of these strategies. Mason et al believe that learner makes the best use of his cognitive strategies by means of metacognitive strategies. Dembosays: “several cognitive strategies can be taught to students, yet, if they do not have metacognitive strategies or skills and not know which cognitive strategy to use in a certain situation or when to change their cognitive strategy, they will not be a proficient learner.” In a comparison between cognitive and metacognitive strategies, Cole and Chan implied the point that cognitive strategies are applied to facilitate learning and fulfill assignment. Yet, metacognitive strategies are used for monitoring this progress. On the other hand, the main action of a cognitive strategy is that the individual is helped with the accomplishment of a cognitive action. Reversely, the main action of a metacognitive strategy is that it prepares the individual for an action information or progress in the same regard. As a result, it is not adequate that students learn about various learning strategies. Rather, they must learn how and when to suitably use strategies [6]. Kang, Keam, and Kang carried out an empirical research as “the relationship between self-efficacy, metacognition, and cognition”. They concluded that progress, problem solving performance, and satisfaction are respectively strong predictors for learning. MittleFehdt and Grotzer examined the active organization of cognitive processes in knowledge transfer for learning various scientific and research phenomena. Metacognitive strategy applied consists of organization and self-control process. Results showed that students clearly expressing their knowledge and use abstract inference to learn special thoughts were more successful learners. In study, Wang, Spenser, and King examined the effects of sophomores’ metacognitive beliefs and strategies on learning a foreign language. Results indicated that metacognitive beliefs regarding the students’ abilities used in learning a foreign language have positive relationship with confidence.

Based on what is said, using more appropriate and efficient teaching method in educational systems is one of the most effective actions which can lead the present education toward success. Hence, identifying obstacles interfering in the accomplishment of this goal is one of the most necessary and basic cases to which the decision makers of this huge system need. This study intends to answer following question: Is there any differences between students taught empirical sciences by heuristic method and those taught by metacognitive method regarding their educational achievement?

Research Method:

This quasi-experimental research was carried out on two groups. A group was taught by heuristic approach and another by metacognitive approach. Research design was implemented using pretest and posttest. The study sample consisted of Masjed Suleiman fourth primary school boy students studying between 2012 and 2013. The
students were randomly clustered. First, a school was selected among Masjed Suleiman primary boy schools. Among fourth grade classrooms, one was taught by heuristic approach and another by metacognitive approach. There were thirty students in each classroom (total sample size= 60). A validated pretest was administered for both groups. Then, they were taught for fifteen sessions. Finally, posttest was administered for each group. Results were analyzed using descriptive and inferential (independent T-test) statistics. Data was collected using a validated questionnaire consisting of forty four choice questions from the last five lessons of book ‘empirical sciences’. Test validity was approved by Masjed Suleiman primary school teachers. Its reliability is 0.77.

**Results:**

To examine the differences in pretest scores between two heuristic and metacognitive groups, independent T-test was administered. Results are listed in Table (1).

**Table 1:** Independent t-test results regarding the difference between heuristic and metacognitive groups pretest scores

<table>
<thead>
<tr>
<th>Index</th>
<th>No.</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>F degree</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>heuristic</td>
<td>30</td>
<td>9.93</td>
<td>3.78</td>
<td>-0.519</td>
<td>58</td>
<td>0.266</td>
</tr>
<tr>
<td>metacognitive</td>
<td>30</td>
<td>9.46</td>
<td>3.15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on Table (1), T=-0.519, FD=58, and Sig. level=0.266 which is >0.01. Hence, the difference between heuristic and metacognitive groups in pretest scores is statistically insignificant. It indicates that the difference between two groups is statistically insignificant at the beginning of instruction.

Research hypothesis: Students taught by heuristic method has different educational achievement from students taught by metacognitive method

To test the hypothesis and compare mean groups, t-test was applied. Results are listed in Table (2).

**Table 2:** Independent t-test results regarding the difference between heuristic and metacognitive groups pretest scores

<table>
<thead>
<tr>
<th>Index</th>
<th>No.</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>F degree</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>heuristic</td>
<td>30</td>
<td>13.16</td>
<td>5.12</td>
<td>1.065</td>
<td>58</td>
<td>0.047</td>
</tr>
<tr>
<td>metacognitive</td>
<td>30</td>
<td>11.83</td>
<td>4.16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on Table (2), T=1.065, FD=58, and Sig. level=0.047 which is <0.05. Hence, the difference is significant at the level of confidence %95. Accordingly, research hypothesis - Students taught by heuristic method has different educational achievement from students taught by metacognitive method - is approved.

**Table 3:** Independent t-test results regarding the difference between heuristic and metacognitive groups pretest scores

<table>
<thead>
<tr>
<th>Index</th>
<th>No.</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>F degree</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>heuristic</td>
<td>30</td>
<td>3.38</td>
<td>2.50</td>
<td>-1.77</td>
<td>58</td>
<td>0.01</td>
</tr>
<tr>
<td>metacognitive</td>
<td>30</td>
<td>2.43</td>
<td>1.20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Concerning the matter that heuristic group mean difference scores (3.38) is larger than metacognitive group mean difference scores (2.43); hence, heuristic method is more effective in teaching empirical sciences to primary school fourth grade students.

**Discussion and Conclusion:**

To examine heuristic group’s educational achievement difference score as compared to metacognitive group, independent t-test was applied. Based on results, T=-1.077, FD=58, and Sig. level=0.047 which is <0.05. Hence, the difference is significant at the level of confidence %95. Heuristic group mean difference scores (3.38) is also larger than metacognitive group mean difference scores (2.43). Hence, heuristic method is more effective in teaching empirical sciences to primary school fourth grade students. Results of this study correlate with the results reported by Rahimi, Ghazi, Hasanbeigi, Chehrazi, Hasanzadeh, NazariSarem, ShabaniSijani, Mao-Sung Nik and Cheng Chen Yen, Scruz, Govel, Sernic, McDaniel, Anderson, Hot, Sachman, Gage and Berlighter and BesigeHouda et al. This is because, in all of these studies, heuristic method is more effective for students’ educational achievement and learning as compared to metacognitive method. Based on this result, it can be said that since heuristic teaching method is an active approach and students are also interested in activities such as emotion pullout, exploration, search, and curiosity, this method is likely to be preferred to metacognitive approach. In addition, implementing metacognitive method may be challenging for teachers. They may not be able to execute this method stages as required.

Since heuristic method is an active student-centered teaching approach, situations must be provided for learners so that they get started asking questions. Teacher-student action and reaction is interactive, intimate, participatory, and accurate. Students’ ideas are welcomed. Although this structure may seem to be a bit complex, teaching-learning process is effective and encouraging. This is because, student is not merely the receiver rather he searches information and solves problem volitionally. This method increases students’ internal motivation, seal, and interest in learning and activity. This is because student actively proceeds learning and
feels more satisfied. In heuristic method, question and answer and students’ reaction expand teaching process and students learn and develop based on their abilities.

Suggestions:

Based on results, some applied points are suggested below:

1. Creating positive thinking and motivation in teachers for applying active methods; especially, heuristic method.
2. It is proposed that in-service courses are administered for making teachers more familiar with active methods for teaching sciences; especially for experienced teachers who have not attended the course.
3. Since teaching and educational psychology experts’ new findings grow so fast, it is suggested that these findings are published in terms of applied journals and provided to teachers with not chance for extracting them from books and sites.
4. Education Department provides researchers with necessary facilities for studying the pros and cons of teaching strategies.
5. Encouraging teachers to attend active teaching methods festivals across area, province, and country.
6. It is suggested that astudy is carried out regarding teachers’ reluctance to use active teaching methods.
7. Teachers’ performance assessment methods shall be revisited. These assessments shall focus on applying suitable teaching methods rather than the percentage of students passed the exam.
8. Special scores shall be considered for teachers using active teaching methods.

REFERENCES