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Effect of the teaching and learning mathematics strategy based on metacognitive scaffolding on instructional efficiency

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Effect of the teaching and learning mathematics strategy based on metacognitive scaffolding on instructional efficiency

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Abstract. Metacognitive scaffolding (MS) with self-questioning is helpful in promoting student problem solving skill and independent learning. MS deals with the process of learning which helps the students to think, control, and monitor their learning. The instructional condition will be more efficient if the performance of student achievement in problems solving needs less than mental effort invested or equivalent. Therefore, the purpose of this paper was to examine the effect of the scaffolding metacognitive strategy on instructional efficiency. The results of quasi-experiments indicated that the MS strategy fulfilled the direct effect to instructional efficiency. This data provide support for the claim that MS strategy is superior in comparison to the conventional teaching. Students in the experimental group showed an overall favorable view towards the implementation of MS strategy. They viewed that the MS strategy is an interesting, new, simple, and easy instructional format to use in mathematics learning.

1. Introduction

According to Skemp [1], there are two types of understanding in mathematics, namely relational understanding and instrumental understanding. First, refer to the knowledge of what to do and why it was done. This understanding is more meaningful, where pupils can understand structural and more relevant mathematical connections and more useful to help long-term motivation. While the latter is only the ability [2,3] to apply the principle (knowing what to do), but without knowing why it was done. This understanding is more mechanical and characterized by rote and uses rules or algorithms. Students who study mathematics with their mental activity understanding will contribute to maintaining, transferring to new situations, and applying the mathematical knowledge they have acquired [4].

Metacognitive is knowledge about self-awareness when solving problems. Basically a person can control and regulate their own cognition through metacognitive [5,6]. Mathematical problem solving is an abstract and complex process and this involves thinking and human reasoning [7]. Mathematical problem solving can instruct pupils to use high-level thinking skills and demand them to use metacognitive treatment.

The mathematical ability of the students is more about mathematical routines, not involving high-level thinking skills, understanding, and metacognitive behavior in problem solving [8]. Students need guidance and connective thinking when faced with difficult tasks and if they are not given the guidance they can not perform their duties, they will get bored [9], and then they will continue to give up on their job with scafolding [9,10]. Defines understanding as a method of presentation and structured information. They argue that mathematical ideas, procedures, or facts are understood if the mental representation of an intrinsic network is part of a representational relationship [11,12].

One of the forms of metacognitive scaffolding is self-questioning which focuses on this study. Questions in self-examination are known as metacognitive questions [13,14]. The self-inquiry strategy is an effective way to promote independent learners. Metacognitive questions such as "What's the problem. What's the part of this problem." However, it is important to help students know the purpose of the given task self-inquiry.

2. Research method

Research methodology which includes research design, population and research sample, treatment, experiment validity threat, study procedure, instrumentation construction, pilot study, data collection procedures and data analysis. This study was conducted by comparing two strategies for teaching and learning mathematics (IE PM strategy and PK strategy) and determining their impact on the four main relational variables (performance, metacognitive awareness, mental effort, and teaching efficiency). Teaching efficiency is determined based on student achievement and mental effort when they solve mathematical problems in the classroom. Therefore, the design of the experiment is considered appropriate to achieve the purpose of this study, as only with convincing experimental data can develop causal relationships [15,16].

3. Analysis and discussion

According to the results of the UKK out of 29 students in the PM strategy group, 23 (79.31%) pupils received "reached and exceeded" grades, 6 (20.69%) students received "not achievable" grade, while 29 pupils in the PK strategy group were 20 (68.97 %) students get grades "reached or exceed", 9 (31.03%) students get a grade "not reached".

Table 1. Respondent profile distribution according to minimum approval criteria.

Mathematical Standart	Group PM strategy	Group PK strategy	Many Students
≥ 77 (Achieved and surpassed)	23 (79.31%)	20 (68.97%)	43 (74.14%)
< 77 (Not yet finished)	6 (20.69%)	9 (31.03%)	15 (25.86%)
Overall total	29 (100%)	29 (100%)	58 (100%)

For students who have achieved the grade achieved and beyond are allowed to follow the subject of the next unit or otherwise obtain approval for the higher level while the pupils who have acquired a tuition have not been required to undergo repair activities to meet the standard criteria, which are achievable and beyond. All students in both PM strategy groups and the PK strategy did not attend tuition classes provided by the school, and before the treatment of both classes had never been used strategy of using metacognitive scaffolding.

Preliminary tests were carried out before experiments were initiated to measure performance, mental effort, metacognitive awareness level, and an index of pupil's teaching efficiency for the treatment group, IE class groups with PM strategies and control class groups IE class groups with PK strategies. The goal of this measurement is to identify the homogeneity of both PM strategy groups and PK strategies on key variables in this study, namely performance, mental effort, metacognitive awareness, and index of teaching and learning situation efficiency. In addition, the three sets of data are also used to see the statistical control of the possible possible effects of independent variables on the dependent variables.

Three sets of pre test data were obtained from pre-test prior to intervention from both PM strategy groups or PK strategies. The first data is to evaluate the performance and the second data is to evaluate the mental invested student's efforts when they solve mathematical problems for pre-test while the third data is to evaluate the level of general metacognitive awareness of pupils while they solve mathematical problems. The teaching efficiency index before treatment is calculated based on student performance and mental data.

Performance variables from pre-test were measured using the Mathematical Performance Test (UPMT). This test is conducted by mathematics teachers from both groups of PM strategy class (K8.2) and PK strategy (K.8.1). Performance measure is the overall performance of pre-test for both PM group strategy group and PK strategy class group. Metacognitive awareness levels referring to the student's metacognitive awareness response during problem solving for pre-test. It has been measured using the scale of the Metacognitive Awareness Inventory (IKMK) rating with their overall metacognitive awareness level as they solve the problem. Additionally, it is also divided into four metacognitive awareness subscales namely awareness subconscious, cognitive strategies, planning, and self-examination.

Furthermore, from the pre-test, a description of the mathematical achievement of both the PM strategy group and the PK strategy is distinguished into two categories of mathematical ability namely low achievement (PR) and high achievement (PT). The differentiation of both the PR and PT categories are achievements referring to the overall pre-test performance min score for both PM and PK groups (my score 65.05). Low achievement (PR) is a test score of less than 65.05 and high achievement (PT) IE test score higher or equal to 65.05. Of the 30 students in the PK strategy group, 16 students are PR categories and 14 students are PT. For the PM strategy group, 15 students are in the category of PT and 15 students in the PR category.

If the mathematical achievement of the pre-test is differentiated into two grades based on the MOH score with a 77 score limit, that is "not achieved" for a test score of less than 77 and reached or exceeded for a score higher or equal to 77 then obtained profile data distribution pupils have been obtained as in Table 2 of the 16 pupils in the PK strategy group showed that all pupils were PR categories of 16 (100%), did not reach the standard, as well as 15 pupils in the PM strategy group where all pupils, 15 (100%), did not reach the standard in pre-test. This is because the standard criteria is less than the mean of the pre-test score of 65.05 <77. Of the 14 students in the PT category for the PK group, 5 (36%) students did not reach the standard and 9 (64%) students had reached or exceeded the standard. Furthermore, 15 pupils from the PM strategy group, 5 (33%) students did not reach the standard, while 10 (67%) students had reached or exceeded the standard of mathematical subjects in the pre-topic straight line equation test. Thus, the pupils of both the PK strategy group and the PM strategy group are based on frequency and percentage numerically compared to their mathematics achievement.

Table 2. Pupil's achievements profile on pre-test.

Mathematical Standart	Low Achievers (PR)		High Achievement (PT)		Amount
	PM Strategy	PK Strategy	PM Strategy	PK Strategy	
< 77 (Not achieved)	15(100%)	16 (100%)	5(33%)	5(36%)	41(68%)
≥ 77 (Achieved)	0(0%)	0(0%)	10(67%)	9(64%)	19(32%)
Amount	15 (100%)	16 (100%)	15 (100%)	14 (100%)	60(100%)

Data analysis uses SPSS Version 19 and is carried out for all the data collected in this study. The results of statistical analysis of pre-test for both groups of PM strategy class and PK strategy were obtained and shown as in the next description. For each variable, mean, standard deviation, and t-test statistic were determined. Comparative analysis using independent t-test samples was used to explain the mean difference in performance, mental effort, metacognitive awareness level, and teaching efficiency index between PM strategy group and PK strategy group.

4. Conclusion

The results of the study showed that PM strategies performed better than PK strategy groups for post-retirement and post-retirement tests. The results of the post-test study showed that the PM strategy group outperformed the PK strategy group for performance variables. This shows that pupils of the PM strategy group have a higher mean than the PK strategy group. This means that the effect of metacognitive symmetry in teaching and learning (PM strategy) has been maintained despite taking 8 weeks after the post-test. The likelihood that pupils have internalized learning methods that use their own basics that are supported by metacognitive question questions, as scaffolding in learning and solving mathematical problems.

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