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The Effect of Cognitive Conflict Strategies on Students' Cognitive Learning Outcomes

Widia[1], Suhirman[2*], Muhammad Suhardi[3], Saiful Prayogi[3], Muhammad Yamin[1], Muhammad Salahuddin[1], Lutfin Haryanto[1], A Haris[1], Ewisahrani[1], E Nursa'ban[1], Ilyas[4], Mujitahid[5]

[1] Sekolah Tinggi Keguruan dan Ilmu Pendidikan (STKIP) Harapan Bima, Bima 84161, Indonesia.
[2] Universitas Islam Negeri Mataram, Mataram 83116, Indonesia.
[3] Universitas Pendidikan Mandalika, Mataram 83125, Indonesia.
[4] Sekolah Tinggi Keguruan dan Ilmu Pendidikan (STKIP) Taman Siswa, Bima 84161, Indonesia.
[5] Sekolah Menengah Pertama (SMP) Satu Atap Gili Trawangan, Lombok Barat 83352, Indonesia.

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Abstract: An important aspect of learning outcomes at all levels of education is cognitive learning outcomes, and to achieve optimal cognitive learning outcomes, multi-method intervention is needed. This study aims to determine the effect of using cognitive conflict strategies on students' cognitive learning outcomes. Experimental research with one group pretest-posttest design was conducted in this study. A total of thirty-five students as the research sample, sample came from one of the high schools in West Lombok, West Nusa Tenggara. Cognitive conflict strategies are conducted in the material of continuous straight motion and uniformly changing straight motion. Measurement of cognitive learning outcomes using a test instrument (essay test) as many as six test items that accommodate cognitive level 1 (C1) to 6 (C6) and these are given to students as pretest and posttest. Descriptively, the results showed that cognitive learning outcomes increased after learning using cognitive conflict strategies (mean: 3. 4803) significantly (p: 0.000) with an n-gain of 0.74 in the high category. These results imply that cognitive conflict strategies are effective for improving students' cognitive learning outcomes.

Keywords: Cognitive conflict strategies; Cognitive learning outcomes; Experimental research

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Introduction

Learning outcomes are the most important part of learning. Learning outcomes are the abilities that students have after receiving their learning experiences (Harris & Clayton, 2019). Assessment of learning outcomes is the process of giving value to the learning outcomes that have been achieved by students based on certain criteria. Learning outcomes can be seen through evaluation activities that aim to obtain evidence data that will show the level of students' abilities in achieving learning objectives (Zlatkin-Troitschanskaia, et al., 2016). Student learning outcomes are essentially changes covering the cognitive, affective, and psychomotor fields that are oriented to the teaching and learning process experienced by students (Ni, et al., 2018).

The national education system and formulation of educational objectives, both curricular and instructional goals generally use Bloom's classification of learning outcomes which broadly divides them into three domains, cognitive, affective, and psychomotor domains (Muzyk et al., 2018). The cognitive domain is concerned with intellectual learning outcomes which consist of six levels, namely: knowledge (C1) understanding (C2), application (C3), analysis (C4), synthesis (C5), and evaluation (C6) (Bloom, 1956).

*Email: suhirman@uinmataram.ac.id

The assessment of the affective domain is a learning outcome that includes five levels, namely: receiving, responding, evaluating, organizing, and characterizing by a value complex. The weight of the scores is arranged increasing, starting from the simplest level to the most complex, the instrument used is a checklist. The psychomotor assessment consists of imitation, manipulation, precision, and articulation. Scores in the psychomotor domain are also arranged to increase in line with the complexity of each level in that domain (Krathwohl & Anderson, 2010). The instrument used is a checklist sheet. Broadly speaking, learning outcomes are influenced by 2 factors, namely internal and external factors. Internal factors such as attitudes, interests, and motivation, as well as student abilities. While external factors, such as facilities, school environment, and learning strategies. The quality of learning is an important factor for learning outcomes (Hinderliter, et al., 2021).

Learning is often identified with the thinking process which is a cognitive activity to acquire knowledge and produce new mental representations. Cognitive processes cannot develop naturally, therefore they must be enriched by various stimuli and various conditions. One of the stimulations that can be used in learning is the use of cognitive conflict strategies. Cognitive conflict is a condition in which there is a conflict in the cognitive structure of students (Akmam et al., 2018). Conflict occurs because of differences in the initial conceptions that students have with their learning experiences (Prayogi & Verawati, 2020). Cognitive conflict occurs when students' mental balance is disturbed by experiences (referred to as "anomaly data") that do not match their current understanding (Prayogi, et al., 2019).

Cognitive conflict strategies involve: (a) identifying the current state of students' knowledge; (b) confronting students with contradictory information; and (c) evaluating the degree of conceptual change between students' initial ideas or beliefs by conducting a posttest after an instructional intervention (Potvin, 2021). To understand cognitive conflict, knowledge of the cognitive conflict process model is very important, because it explains the stages in which cognitive conflict occurs and how to resolve the resulting conflict. Cognitive conflict processes occur when a learner: (a) recognizes anomalous situations, (b) expresses interest or otherwise regarding the existing conflict, and (c) engages in a reassessment of the cognitive process situation. When students realize that an existing situation does not match their concept, they become interested or otherwise about this situation (Schmidts, et al., 2020).

Cognitive conflict strategy is a strategy to change the conception that allows students to realize their misconceptions. If students realize the discrepancy between the knowledge they already have with new experiences, there will be a conflict in their minds (cognitive conflict). Students will doubt the knowledge they already have and form new knowledge. This is in accordance with Piaget's view that if the balance between what is understood and what is encountered is disturbed, children have the opportunity to develop. If a person's schema cannot be used to deal with new experiences, then there is a balance between what is understood and what is encountered. Naturally, humans always try to eliminate disequilibrium and develop new schemes or modify old schemes until there is a balance (Waxer & Morton, 2012).

Cognitive conflict occurs when there is a conflict between two schemata, namely the occurrence of inconsistencies or contradictions. Inconsistency or conflict in question is the existence of understandings related to a concept or information that is contradictory, inconsistent, or not integrated. Sigel in Lee, et al. (2003) describes three types of cognitive conflict, namely: (1) internal cognitive conflict, namely conflict between two conflicting ideas in the cognitive structure or conflict between understandings in the cognitive structure, (2) external social conflict, namely conflict between two external events or information from outside. This conflict can be explained to someone who witnesses two people arguing or reads a discrepancy of information from different sources; and (3) internal-external conflicts, namely conflicts between a person's understanding of information in his cognitive structure with external events or sources of outside information. But the three types of cognitive conflict proposed by Siegel are a conflict that occurs as a result of the understanding of the information received or that has been stored in a person's cognitive structure do not integrate into one understanding of the same concept.

Cognitive conflict is defined as a conflict between cognitive structure (i.e. an organized knowledge structure in the brain) and environment (i.e. an experiment, demonstration, peer's opinion, book, or something like that), or a conflict between conceptions in cognitive structure (Madu & Orji, 2015). Broadly speaking, the main steps in the cognitive conflict strategy are (1) identification of students' wrong concepts, (2) the creation of conflict conditions in students through the provision of experimental facts, anomalies, contradictions, (3) assisting in the occurrence of equilibration through questions, providing information, (4) reconstruction of student understanding.

Teachers as facilitators and mediators of learning, when misconceptions arise, should present cognitive conflicts so that there is an imbalance in students. The cognitive conflict presented by the teacher is expected to be able to make students aware of their misconceptions and in the end, they reconstruct their conception

towards a scientific conception. Thus, the learning process, especially chemistry learning, will create a meaningful learning atmosphere. Meaningful learning occurs when information is related to relevant concepts contained in a person's cognitive structure (Wang, et al., 2020).

This study aims to determine the effect of using cognitive conflict strategies on students' cognitive learning outcomes. Learning outcomes in this study refer to cognitive learning outcomes, where the dimensions of cognitive processes are divided into six levels, namely: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creates (C6) (Krathwohl & Anderson, 2010).

Method

This research is an experimental study using one group pretest-posttest design. The research sample was 35 students in one of the senior high schools in West Lombok, West Nusa Tenggara. Cognitive conflict strategies are conducted in physics learning on continuous straight motion and uniformly changing straight motion materials. Data on students' cognitive learning outcomes were collected using 6 items of essay learning outcomes test with indicators C1-C6. The results of the data analysis of students' cognitive learning outcomes are then categorized using the categories of cognitive learning outcomes as presented in Table 1.

Table 1. Range of Learning Outcomes

Range	Category
3.85–4.00	A
3.51-3.84	A-
3.18-3.50	B+
2.85-3.17	B
2.51-2.84	B-
2.18-250	C+
1.85-217	C
1.51-184	C-
1.18-150	D+
1.00-117	D
0.00-0.99	E

The increase in students' cognitive learning outcomes was statistically analyzed with the help of SPSS for Windows 16 using parametric statistical analysis with the prerequisites that the data were normally distributed and had homogeneous variance ($p > 0.05$). The results of statistical analysis were also strengthened by the n-gain score of students' cognitive learning outcomes and were further categorized according to Table 2 (Hake, 1999).

Table 2. N-*gain* Criteria

Score Range	Criteria
> 0.70	High
0.30 – 0.70	Moderate
< 0.30	Low

Result and Discussion

Data on students' cognitive learning outcomes were collected using an essay test instrument of six items. The test instrument used was first validated in terms of content and constructs by 2 experts before being used to collect data on students' cognitive learning outcomes. Student learning outcomes data is a cognitive classification based on levels C1-C6. Data on student learning outcomes were analyzed using the ANOVA test to determine the distribution of the data and Levine's test to determine the data variance. The results of the analysis of the distribution and variance of student learning outcomes data are presented in Table 3.

Table 3. The Results of the Normality and Homogeneity test

Data	N	Normality	Homogeneity
		Sig	Sig
Pretest-posttest	35	0.543	0.673

Based on the results of the analysis of the distribution and variance of student learning outcomes data as presented in Table 3, it can be seen that the data are normally distributed (0.543) and have homogeneous variance (0.673) because they are greater than the alpha test (0.05) so that a paired sample t-test is carried out for determining the increase in the score of students' cognitive learning outcomes before and after learning. The data from the analysis of the increase in students' cognitive learning outcomes are presented in Table 4.

Table 4. Improving Student Cognitive Learning Outcomes

Group	N	Score	Mean	DS	Sig.
Pretest & posttest	35	Pretest	1.9510	0.48493	0.000
		Posttest	3.4803		
		n-gain	0.74		

Table 4. shows that students' cognitive learning outcomes increased after learning using cognitive conflict strategies (mean: 3.4803) significantly (Sig: 0.000). These results are also supported by the results of the n-gain analysis of students' cognitive learning outcomes after learning with a value of 0.74 with a high category so that it is declared effective for improving students' cognitive learning outcomes. The increase in students' cognitive learning outcomes is in line with Madu & Orji's (2015) statement that learning using cognitive conflict strategies requires students to construct their knowledge. Students go through a

process of assimilation and accommodation. In the process of assimilation, the new information obtained by students is matched with concepts that already exist in their minds. If the new information is not in accordance with the concept in his mind, the student will change the concept in his mind through the accommodation process to strengthen understanding of the concept and improve student learning outcomes.

Cognitive conflict strategy is a conceptual change strategy based on the constructivism view, which is a learning strategy on how to make students' minds aware of their misconceptions so that through the accommodation process it is hoped that they can turn into scientific conceptions. Many studies revealed that the theory of conceptual change is influenced by the philosophy of constructivism. To cause cognitive conflict in students, it can be done by presenting counter-examples, analogies, demonstrations, and experiments (Verawati & Afifah, 2018).

Broadly speaking, the main steps in the cognitive conflict strategy consist of 4 phases, namely identification of misconceptions, creation of conflict conditions, assisting equilibration, and reconstruction of student understanding. The first phase shows that during learning students tend to experience misconceptions about the concepts of displacement, distance, and instantaneous velocity in terms of changes in time. This phenomenon must be corrected so that learning can run effectively. In line with these statements and findings, Prayogi et al., (2018) state that students' prior knowledge can help direct students' concepts towards the correct concept.

The step that needs to be done in learning is to provide a conflict situation (phase two). The teacher's goal is to provide this conflict situation so that students realize that their concepts are wrong by providing counter examples. In this phase, the teacher does not directly blame students' preconceptions and force students to accept the new concepts being taught, but students are directed to change their wrong preconceptions. According to Ausubel's meaningful theory, meaningful learning occurs when there is a process that links new information to relevant concepts that already exist in a person's cognitive structure (Wang, et al., 2020).

The third phase is the provision of assistance so that equilibration occurs. The provision of assistance so that there is equilibration in students, according to Piaget's theory which states that cognitive and learning changes will take place if the schema is disturbed. This disturbance will cause accommodation that leads to the creation of a new equilibrium. Assisting in this equilibration process can be through questions or providing information. The final phase of the cognitive conflict strategy is to reconstruct students' understanding to strengthen students' understanding of the concept so that the previously experienced misconceptions have disappeared and turned into true concepts that can be firmly embedded. The processes as described are carried out during learning so that students' cognitive learning outcomes experience a good increase using cognitive conflict strategies.

In addition to presenting the phenomenon of cognitive conflict, student interaction with the environment is also emphasized during learning to help students better understand the material being studied. Cognitive development largely depends on how far children will actively interact with their environment. In the classroom, the presentation of knowledge by encouraging students to find their knowledge is done through interaction with the environment and with teaching materials.

Conclusion

Based on the results of the study, it can be stated that the use of cognitive conflict strategies has a significant effect on improving students' cognitive learning outcomes on the subject matter of uniform straight motion and uniformly changing straight motion with a high N-gain category. The obstacles found in the study were the difficulties of students in understanding the concepts of displacement, distance, and instantaneous acceleration, so that in learning it is important to provide authentic phenomena related to the materials to be studied to identify students' conceptual difficulties comprehensively so that the treatment in learning is more effective.

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