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The Influence of *Conflict Between Ideas* and *Discrepant Event* on Conceptual Changes in Physics Learning

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ABSTRACT

Individuals when faced with a confrontation situation or a new idea that is unusual in everyday life, then in their cognitive structure there will be a conflict so that doubts arise why the existing conception is not appropriate and whether to change the previous conception according to the new situation or idea. This study aims to test the effectiveness of the idea confrontation strategy in physics learning in improving high school students' understanding of the effect of force on the motion of objects. The research method used is a quasi-experimental with a one group pretest-posttest design applied to one group. The research sample was 40 first-grade high school students where the type of confrontation source was generated by two categories, namely conflict between ideas and discrepant events. The conclusion obtained is that the idea confrontation strategy can significantly improve overall student learning outcomes but cannot differentiate between ability groups, can correct students' misconceptions about the effect of force on the motion of objects both based on the target concept and the type of concept, and can encourage changes in student conceptions.

Keywords: *conflict between ideas, discrepant event, Conceptual Change, Physics Learning.*

INTRODUCTION

An individual who learns does not only imitate or reflect what is taught or read, but creates understanding or knowledge actively and continuously (Herawati, 2020; Maâ, 2018; Suardi, 2018). Knowledge or understanding is formed by someone actively through the learning process, not just passively received from others. Learning is an active process that takes place in students through the mediation of teachers and subject matter, so that learning outcomes do not depend on what the teacher conveys, but how students process the information received and process it based on the understanding and initial knowledge they have (Rosa, Aththibby & A'yun, 2023; Wati, et al., 2024; Widyaningtyas, et al., 2024).

Several studies have shown that most physics concepts have misconceptions, motion and force in the field of mechanics are one of the concepts that are widely understood differently by students. This happens because the concept of motion and force is directly related to students' daily experiences which are abstract and these experiences do not correspond to the actual concept (Rusli & Haris, 2016). Based on daily experiences, students have the conception that "if there is no force, then there will be no movement in an object". As a result, they think that if there is no movement at all, then there is no force acting on the object. "Action and reaction forces are understood to work at the same point of the same object", whereas according to physics the two forces work on different objects. Some students also stated that "constant force causes constant velocity", whereas in physics constant force causes constant acceleration. Students experience misconceptions because they connect one concept to another through partial understanding and do not understand the concept as a whole, as a result they make the wrong conclusions (Zulvita, Halim, & Ellisa, 2017).

Identification of problems is needed to distinguish students who have misconceptions from students who do not know the concept before overcoming misconceptions. According to Piaget's opinion regarding conceptual change, misconceptions occur because they involve the accommodation process, namely the process of changing schemas when students obtain new information that is inconsistent with previous information (Rachmawati & Supardi, 2021). There are four conditions that must be met for conceptual change to occur through the accommodation process, namely; (1) dissatisfaction with the initial concept (dissatisfaction), (2) clarity regarding the new concept (intelligibility), rational, and can be used to solve new problems, (3) the new concept must make sense (initial plausibility), consistent with existing theories or knowledge, and (4) success of the new conception (fruitfulness) (Makhrus, Widodo, & Agustin, 2018).

Every material in physics is interrelated, so misconceptions will continue to occur when students study other materials if these misconceptions are not corrected (Sari, Djudin, & Oktavianty, 2018). Before learning, students' cognitive structure has formed various preconceptions about events and understandings of concepts. It is important to realize that the preconceptions are not necessarily in accordance with the statements accepted by scientists. A mixture of old concepts (which are not necessarily true) and new concepts that may not be understood correctly will occur if new concepts are directly inserted into students' minds or cognitive structures. This mixture of concepts becomes an understanding or conception that is understood differently from the scientist's conception and becomes a factor causing students' difficulties in learning physics.

Facing students with new ideas or situations which according to their perception contradict their previous understanding, then after conducting rational and reasonable discussions, questions and answers, demonstrations or experiments, triggering a process of reorganization and restructuring of concepts in their cognitive structure, so that the new concept can be accepted student.

MATERIALS & METHODS

This study used a quasi-experimental method with a one-group pretest-posttest design on one group of students, with the following steps (Dreyfus et al., 1990): The first stage is to identify students' conceptions before starting learning in class (disequilibration), The second stage is to generate conflict or conflict situations in students' cognitive structures (reformulation), and The third stage is to prepare and provide exercises, questions and problems, to strengthen the new concepts that the students have (awareness). These stages are also in accordance with the idea confrontation strategy applied by Kwon et al. (2000) in the form of a theoretical model, namely the preliminary stage, the conflict stage, and the resolution stage as shown in Figure 1.

The research sample used was one group of first grade high school students who were determined based on the cluster random sampling technique with the consideration that the grouping of students in each class was not based on ability level or grade ranking so that the classes had homogeneous abilities.

The instruments used were objective tests consisting of 30 items with 4 answer options accompanied by reasons, classroom interaction observation sheets, student questionnaires, and student and teacher interview guidelines. Each test item created has been adjusted to the learning outcome indicators (changes in conception) so that it meets the content validity criteria, while the test reliability index is 0.87.

To test the significance of the difference, t-statistics are used, while to describe the variables, percentages are used. For the analysis of changes in student conceptions, analysis guidelines are used which are compiled based on their suitability to scientific conceptions with the criteria of change, in accordance with scientific concepts, conceptions are still limited (not complete), or do not correspond to scientific conceptions.

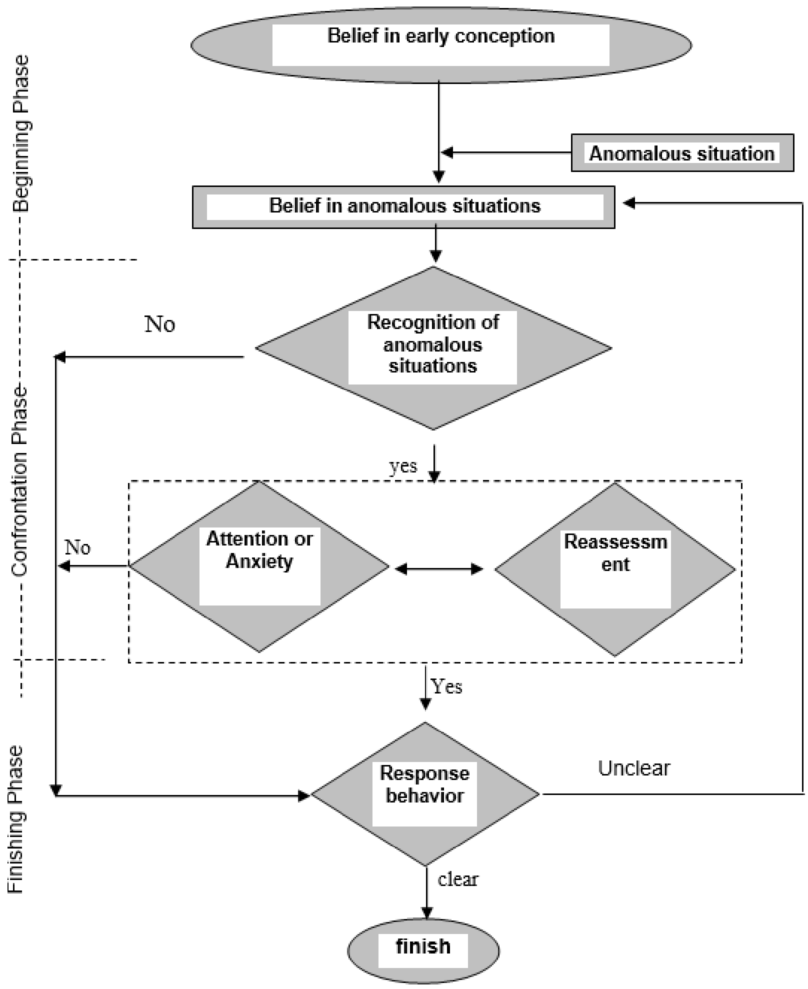

Figure 1: Theoretical Model of the Idea Confrontation Process

RESULT & DISCUSSION

Based on the results of the t-test, it was obtained that the average overall student learning outcomes before and after learning were significantly different, but the differences in learning outcomes were not significant between student ability groups. Based on data analysis, it is known that the increase in the average student learning outcomes after learning was achieved in a fairly narrow range, namely 10.97%, where the increase in the average learning outcomes for each group did not differ much. Based on the subcategory of learning outcomes the student achievement profile can be described as shown in Table 1.

Table 1. Learning Outcome Categories based on Student Ability Level

Learning Outcome Categories	% Rata-rata			T_{count}	$t_{0,95(38)}$	conclusion
	Pretest	Postest	Gain			
Visual images	22,4	35,0	12,6	4,07	1,68	Significant
Kinaesthetic images	21,2	36,6	15,4	4,13		Significant
Propositional knowledge	17,9	23,7	5,8	2,64		Significant
Mathematical knowledge	18,0	28,2	10,2	5,45		Significant

Students' understanding of the concept of motion and force based on the target concept (Table 2), experienced an average percentage increase of between 4.8% and 18.3%. The highest increase was achieved in the target concept of Newton's Third Law, this is because the essence of the concept of action-reaction force which lies in the magnitude of the force, the direction of the force, and the point of capture which are the subject of discussion is able to improve students' understanding. Changes in students' understanding of Newton's First Law have not been maximized because of the low knowledge of students about the essence of the concept of "inertia" which describes the natural state of an object, namely still or GLB. An object will be still if no total force acts on the object, it is easy to understand, but "an object will move in a straight line at a constant speed (GLB) if there is no total force acting on the object", is still difficult for students to understand.

Table 2. Profile of Student Understanding Based on Target Concepts After Learning

Target Concept	Concept	Test Item Number	FINAL TEST SCORE (POST TEST)							
			Score Frequency						total score	%
			0	1	2	3	4	5		
Newton's First Law	Newton's First Law	1	4	19	-	1	5	8	267	27,4
	Inertia	6	2	23	2	1	-	11		
	GLB	7	22	10	5	-	-	2		
	Natural conditions	12	9	21	3	1	1	4		
	Resultant force	17	25	8	6	-	-	-		
Newton's Second Law	Newton's Second Law	2	6	21	1	-	5	6	239	24,5
		18	7	18	11	3	-	-		
	Force	8	23	5	6	-	2	3		
		13	18	10	5	-	1	5		
	Acceleration	11	25	8	3	-	1	2		
Weight	Massa	3	13	7	10	-	1	8	331	34,0
	Acceleration of Gravity	4	8	28	1	-	-	2		
	Weight	9	22	2	-	-	2	13		
		19	5	7	15	3	2	7		
	Gravity	14	14	9	11	-	-	5		
Newton's Third Law	Newton's Third Law	5	10	11	6	-	9	3	357	36,6
		10	4	6	4	-	2	23		
		20	11	4	23	1	-	-		
	Contact force	15	16	17	1	-	2	3		
	Action reaction style	16	18	9	4	-	4	4		
The ideal maximum score for each target concept is 975.		Average							298,5	30,6

Based on the type of concept, the average percentage of students' understanding based on the type of concept before and after learning based on ability level is presented in Table 3.

Table 3. Level of Student Understanding Based on Concept Type

Concept	% Average			t_{count}	$t_{0,95(38)}$	conclusion
	Pretes	Postes	Gain			
Concepts that state properties	27,1	41,3	14,2	4,26	1,68	Significant
Concepts that are based on principles	19,6	31,0	11,4	7,98		Significant
Concepts that state processes	10,3	15,4	5,1	0,97		Not Significant

Table 3 shows that, students' understanding of the concept stating the nature experienced an average increase of 14.2%, the concept based on the principle experienced an average increase of 11.4%, while the concept stating the process experienced an average increase of 5.1%. For the two types of concepts, the t_{count} was obtained > t_{table}. So it can be concluded that students experienced an increase in understanding of the concept stating the nature and the concept based on the principle. In the concept stating the process, there was no significant difference, because at $\alpha = 0.05$ the $t_{count} < t_{table}$ was obtained.

Changes in students' conceptions of motion and force (Table 4) predominantly occurred in positive patterns in both the sub-categories of visual images, kinaesthetic images, propositional knowledge, and mathematical knowledge learning outcomes. Positive pattern changes are changes that lead to better conceptions than previous conceptions. This proves that the cognitive conflict strategy applied in learning is able to encourage the creation of learning situations that allow students to develop their cognitive skills. Although in this study, the influence of other uncontrolled variables such as; history, maturation, testing effect, and statistical regression cannot be ignored (Suryabrata, 2018).

Table 4. Proportion of Changes in Students' Conceptions of Motion and Force

Change Characteristics	Proportion of Change (%)			
	Vis.	Kin.	Prop.	Mat.
Conception change pattern:				
a. Positive (type P):				
1) High Family	11,8	9,7	10,7	13,4
2) Medium Family	22,1	23,1	19,6	26,3
3) Low Family	12,3	8,2	7,3	15,4
b. Negative (type N):				
1) High Family	4,0	6,7	6,8	1,9
2) Medium Family	10,8	8,2	12,8	4,5
3) Low Family	2,6	8,2	7,7	1,3
c. Fixed (type C):				
1) High Family	9,7	9,2	8,1	10,3
2) Medium Family	18,5	20,0	18,8	20,5
3) Low Family	8,2	6,7	8,1	6,4
Conceptual changes become:				
a. In accordance with scientific concepts	13,3	27,7	15,4	3,2
b. Incomplete/limited	26,7	7,7	9,8	38,5
c. More general/broader in nature	2,1	3,1	9,4	1,9
d. Not in accordance with scientific concepts	4,1	2,1	2,6	6,4
Dominant types of conceptual changes:				
a. Positive (type P):	(P5)	(P6)	(P6)	(P9)
1) High Family	3,1	3,6	2,2	4,5
2) Medium Family	2,6	6,1	3,8	8,3
3) Low Family	4,0	3,6	1,7	5,8
b. Negative (type N):	(N11)	(N4)	(N8)	(N8)
1) High Family	1,0	1,5	1,7	0,6
2) Medium Family	2,1	1,5	2,2	0,6
3) Low Family	0	1,0	1,7	0,6

Based on Table 4, it is also apparent that the form of strong restructuring change is the change in students' conceptions into conceptions that are in accordance with scientific concepts, with an average proportion of 15%. The average proportion is distributed in each subcategory of learning outcomes, namely; visual images (Vis) reaching a proportion of 13.3%, in kinaesthetic images (Kin) 27.7%, propositional knowledge (Prop) 15.4%, and mathematical knowledge (Mat) 3.2%. The form of weak restructuring change occupies a relatively larger proportion than strong restructuring, with an average of 28.6%, namely in each subcategory of learning outcomes visual images reaching a proportion of 32.9%, in kinaesthetic images 12.9%, knowledge 21.8%, and mathematical knowledge 46.8%. It is understandable that to change students' initial conceptions into conceptions that are in accordance with scientific concepts, rational evidence is needed so that it defeats the initial conceptions (beliefs) held by students. Several studies show that students' conceptions of mechanics (Newton's laws of motion) are very resistant to change (Sequeira and Leite, 1991; Sitepu & Yakob, 2019; Rizkita & Mufit, 2022).

The proportion of conceptual changes that occur in groups of students with medium and low abilities tends to be almost the same as in groups with high abilities. This is an indication that the application of the idea confrontation strategy in learning motion and force can help students who are the majority of individuals in the class who must be motivated and guided so that a "learning process" occurs in students using their abilities to adapt to new experiences.

Based on the answers to the questionnaire given by students, it is known that 81% of students like physics lessons, the reasons vary, including because they are related to everyday life, include knowledge of the earth and celestial bodies, physics can be applied to electronic devices, there are always experiments to prove the truth, want to enter the science department, the concepts are interesting, and foster accuracy. Although 65% of students have difficulty understanding the concept of motion and force, the problems faced can develop creativity (73%) and demonstrations/practice are the preferred stage (81%) and with group discussions they admit that they can more easily understand the concepts being studied (96%). In order for learning motion and force to further improve student understanding, they suggest several things related to the implementation of practicums, practice questions, summaries/notes, group discussions, and an interesting learning atmosphere and teachers pay attention to students with low abilities.

CONCLUSION

Based on data analysis, findings and discussion in this study, it can be concluded that; 1) The idea confrontation strategy can improve student learning outcomes after learning, but cannot differentiate between students in the high, medium and low ability categories, 2) The idea confrontation strategy can improve conceptual understanding of motion and force, both based on the target concept and the type of concept, 3) The idea confrontation strategy can encourage changes in students' conceptions about the influence of force on the motion of objects, 4) The idea confrontation strategy has advantages including; (a) Can create a dynamic learning atmosphere, with various cognitive, physical and mental activities of students through variations in methods applied in learning, (b) Can help students optimize construction abilities in their cognitive structures, to improve understanding of the influence of force on the motion of objects, 5) The idea confrontation strategy applied in the learning model has limitations including; (a) Requires students' initial abilities in understanding concept attributes and relationships between concepts, before assessing and acknowledging new ideas or situations faced by them, (b) Requires teachers' accuracy in selecting and determining odd ideas or events, which are adjusted to the level of students' cognitive development. (c) Implementation of the learning model requires a relatively longer time. (d) The type of concept that states the process is only measured by one test item, so it does not reflect the comprehensiveness of the concept that students must understand, and 6) The idea confrontation strategy applied in the learning model received a positive response from students, because it makes it easier to understand the concept of motion and force, and the situation or

Declaration by Authors

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