

Consistency and the Effectiveness of Students' Concept Understanding Against the Concept of Dynamics Using Force Conceptual Inventory (FCI)

*Neni Triana, Darsikin, & Sahrul Saehana

Science Education Masters Postgraduate – Tadulako University, Palu – Indonesia 94118

Email corresponding author: nenitriana.oke15@gmail.com

Article History

Received 15 September 2023

Revised 20 October 2023

Accepted 17 November 2023

Keywords:

Consistency & Effectiveness of
Concept Understanding, FCI
Assessment

Abstract

The purpose of this research to analyze the consistency and effectiveness of students' conceptual understanding. This research is a descriptive study using a qualitative approach. The subjects of this research are students of class X MIA who have studied the material of particle dynamics 42 people. The instrument used was a test of understanding the concept of particle dynamics in the form of a reasoned multiple choice test of 23 numbers and a questionnaire on the effectiveness of students' understanding of concepts. The results of data analysis show that students who have good concept understanding skills have a level of consistency and effectiveness in answering questions. Because the questions are answered in detail and systematically. Students with sufficient conceptual understanding skills have a low level of effectiveness and the answers to questions are not answered in detail, not systematically. This is marked by the scribbles of each answer, understanding the problem,

doi: 10.22487/j25490192.2023.v7.i2.pp.80-85

Introduction

Physics is a collection of laws, theories, principles, rules or formulas that are built according to the study. Learning physics is not enough just to remember, it is necessary to understand each material taught because physics material is a set of interconnected concepts. Physics learning that only provides a collection of facts and knowledge to students results in students' low conceptual understanding abilities and does not develop intellectual freedom (Munfaridah., et al 2017).

Difficulties experienced by students during the learning process are difficulties in learning abstract concepts, mathematical calculations, understanding material with complex concepts, and completion). Students are said to be successful in learning physics if students are able to understand concepts, understandings, laws, and theories correctly (Nawati., et al 2017). Understanding a person's concept is formed from natural phenomena or natural phenomena they see. The ideas, ideas, and initial understanding are what are referred to as alternative concepts or preconceptions. If the alternative concepts that students have are the same as understanding scientific concepts, then students experience understanding concepts but if the alternative concepts that students have are different from understanding scientific concepts, the students experience misconceptions (Jusriana., et al, 2019).

Given that understanding the concept is the first step that students must have to achieve other

physics goals, it is necessary to make an effort to find solutions to these problems. If students' understanding is left low, the achievement of physics learning objectives will be difficult to implement (Pratiwi., et al 2025). Another impact that will arise is the lack of student interest in studying physics. This of course will hinder the process of developing physics in the future. Field facts show that the understanding of physical concepts that teachers and prospective teachers have is still lacking (Nadhor & Taqwa 2020).

Understanding the concept is one of the skills or skills (Hidayat., et al 2020). Consistent understanding in solving problems can lead to the same or permanent results. Likewise, in building an argument, it is necessary to have a consistent attitude to defend an argument. Consistency can also arise if the things that are done are always the same in solving problems or the same actions or habits (Fiorella, 2020). Understanding the concept that is not good will cause various problems in physics, especially in terms of problem solving (Sarkiti & Sundari).

The consistency of student responses in understanding physics concepts requires more understanding from students to see the equivalence of physics problems as outlined in various ways. The indirect impact of this consistency is on the consistency of representation and scientific consistency. Consistency of representation is the ability to use different representations consistently (whether true or false) on questions that have the same context and content, while scientific

consistency is a special case of representational consistency which is only possessed in terms of representation and from a scientific point of view students' answers. true (Paramita., et al 2018).

Consistency in understanding physics concepts demands a deeper understanding. Student consistency brings students to a better level of understanding in seeing various problems. Instrument Force Conceptual Inventory (FCI) evaluate the ability to understand concepts and the effectiveness of students in learning. FCI has been proven in the field of educational research to measure understanding of concepts. FCI is a diagnostic test designed to determine the level of students' understanding of physics concepts, assessing the effectiveness of evaluations at various levels as an introduction to physics teaching (Handika., et al 2016). The material contained in the FCI is essential for teachers and students to avoid misconceptions (Amin., et al 2017).

The learning process is all joint efforts between teachers and students to share and process information. The expectation from the learning process is that the knowledge provided will be useful for students and become the basis for continuous learning. The existence of better changes to achieve a positive improvement marked by

changes in individual behavior in order to achieve an effective and efficient teaching and learning process will be achieved from a learning process. Intellectual abilities and critical thinking will be formed from a learning process (Kurniasari., et al 2020).

The effectiveness of learning is a measure related to the level of success of a learning process (saregar., et al 2017). To achieve maximum learning, the effectiveness of learning is very necessary for the effectiveness of the learning process with regard to the way, the efforts of techniques and strategies used in achieving goals optimally, precisely and quickly (Fatmawati & Sujatmika 2018). Student learning time is the time used to learn the subject matter or to practice certain skills. While effective student learning time is the time used by students in the teaching and learning process provided by educators to get optimal learning outcomes in accordance with what is expected (Rahmi., et al 2020).

Responding to the problems above, the author raised this problem with a study entitled "Consistency and Effectiveness of Students' Concept Understanding in State Senior High Schools Kab. Sigi Against the Concept of Dynamics Using the Force Conceptual Inventory (FCI)".

Materials and Method

This research is a descriptive research with a qualitative approach. This research was conducted in Seven SMAN Kab. Sigi to see the consistency and effectiveness of students' understanding of concepts with research subjects 42 students consisting of 11 men and 31 women. The questionnaire instrument on the effectiveness of students' understanding of the concept used 28 numbers using a Liker scale from 1 to 5 with alternative answers, namely strongly agree, agree, neutral, disagree and strongly disagree with an average score of 140 correct which was tested and tested (choice of double reasoned) with alternative answers a, b, c, d and e which were tested for construct validity, namely validity testing which used the opinions of certain experts in this case the instrument was consulted with expert lecturers (validators) who supervised the field and empirical tests were tested by means of comparing the existing criteria in the instrument with empirical facts that occur in the field, it can be stated that the instrument has high validity. Based on the test results which were analyzed using the SPSS version 22 program, 23 items were declared valid.

The results of the reliability test are the extent to which the instrument procedure can produce a consistent and reproducible value. The higher the reliability coefficient means the higher the reliability of an instrument, the greater the reliability coefficient ranges from 0.00 to 1.00 if the reliability coefficient is getting closer to 1.00 then this means

Results and Discussion

The results of research conducted in seven SMAN Kab. Sigi by assessing students' conceptual understanding with the subject of particle dynamics with a total of 42 students having different levels of understanding. The question indicators that must be achieved are as shown in Table 1.

Table 1. Indicator Questions for Dynamics

No	Question Indicator	Number Question
1	Determining problems about Newton's Laws	1
2	Analyzing Newton's second law on a block	2
3	Newton's law of tension in ropes	3 & 21
4	Solve problems about forces acting on objects	4 & 5
5	Analyzing problems that occur in the working force on the elevator	6
6	Analyze the problem of acceleration on an inclined plane	7
7	Determine the magnitude of the force experienced by an object	8
8	Solving problems about the acceleration experienced by an object	9
9	Determine the distance traveled by an object	10
10	Determine the speed of an object on a horizontal plane	11
11	Solve problems about the centripetal force on an object.	12

12	Determine the force of 2 objects experiencing friction	13
13	Determine the coefficient of friction experienced by an object on an inclined plane	14
14	Solve the problem using the equation for the moment of force	15
15	Students are able to convert SI	16
16	Students are able to determine the distance experienced by a car acting on an object	17
17	Students understand the notion of normal force	18
18	Determine the resultant force acting on an object	19
19	Determine Newton's law problems on a flat plane	20
20	Determine the problem of an object undergoing a change in velocity	22
21	Determine the comparison problem that occurs in the acceleration of 2 objects	23

The results of the analysis of the assessment of understanding student concepts based on the number of questions as much as 23 items can be seen in Table 2.

Table 2 Average Percentage Consistency of Concept Understanding on each Dynamics Matter

No Questio n	Percentag e Consisten cy (%)	Average Percentage of Respondents (%)		
		Understan d Concept	Misconcepti on	Don't Understan d Concept
1	42.86	38.09	4.76	57.1
2	78.57	73.8	4.76	21.4
3	83.33	80.95	0	19.04
4	80.95	66.7	11.9	21
5	73.81	71.4	0	28.6
6	54.76	59.5	0	40.5
7	85.71	88.09	0	11.9
8	76.19	74	2.38	23.8
9	76.19	76.2	0	23.8
10	90.48	88	2	9.5
11	83.33	85.7	0	14.3
12	80.95	81	2	16.7
13	88.1	88	0	12
14	78.57	78.5	0	21
15	64.29	60	5	35.7
16	88.1	88	0	12
17	88.1	88.3	9.5	7.1
18	69.05	69	0	30.9
19	85.7	88	0	12
20	11.01	14.3	0	85.7
21	76.2	69	2	29
22	90.48	90.5	0	10

23	90.48	90.5	0	10
----	-------	------	---	----

The percentage of students' conceptual understanding in solving Dynamics Problems using the FCI assessment has a different understanding by each student. The average percentage obtained in solving the Dynamics Problem is that students who understand the concept are 74.22%, students who have misconceptions are 1.93% and students who do not understand the concept are 24.13% with a total of 42 students.

Discussion

This study aims to analyze the consistency and effectiveness of students' understanding of concepts in solving Dynamics questions conducted in seven SMAN Kab. Sigi class X MIA for the 2020/2021 academic year with a total of 42 students who worked on reasoned multiple choice questions with the Dynamics material presented in 23 questions. which have different levels of consistency and understanding based on the FCI assessment seen from students' conceptual understanding abilities.

Based on the results of the study, it can be seen that there are differences in the consistency of students' conceptual understanding on each of the existing indicators where the percentage of questions with a very high percentage value of consistency is in questions number 22 and number 23 with a percentage value of 90.48% consistency and a percentage level of understanding 90, 5%. The level of concept understanding is very influential on the consistency of students in answering questions, it can be said that if students work on questions with the right answers and the right reasons, then the student can be consistent in understanding the concept but if students' knowledge is low or experiencing misconceptions, it does not close. the possibility of the student is not consistent in working on the questions given.

The percentage of students who do not understand the concept is found in questions number 1 and number 20 with a consistency percentage of 11.01% and 42.86%, with a percentage level of not understanding the concept of 85.7% and 57.1%, respectively. This is caused by students experience misconceptions in interpreting questions, misconceptions in interpreting pictures and their descriptions, and misconceptions in analyzing questions so that students' understanding and consistency are low (Melisari, et al 2020). To measure the level of knowledge and understanding of students in understanding concepts can be done in 4 ways, namely we can ask students to (1) define the concept; (2) identify the characteristics of the concept; (3) relate the concept to other concepts; (4) identify or provide examples of concepts that have never been encountered before.

Misconceptions in understanding the problem, namely students experience misconceptions in interpreting questions, misconceptions in interpreting pictures and their descriptions and misconceptions in analyzing questions so that student consistency greatly affects the level of misconceptions. The reason is that students' reasoning is incomplete/wrong and students' abilities are low, so students experience misconceptions or even students do not understand existing concepts and are inconsistent in answering questions (Safriana & Fatmi 2018).

The factors that show that the level of consistency of student understanding is very low, this is because students have difficulty in answering questions according to (Adianto & Rusli, 2021) students who have difficulty are categorized into 3 types, namely (1) difficulties in understanding concepts, (2) difficulties in applying principles and (3) difficulty in solving verbal problems. This is what causes students not to understand the concept of the questions given and experience inconsistency in solving problems.

Based on the results of the percentage of students' understanding of the concept of consistency, students who understand concepts do not necessarily experience consistency and misconceptions students can experience consistency and inconsistency in solving problems. For students who do not understand the concept, it can be categorized as inconsistent in answering and giving reasons for the questions being worked on.

Students' misconceptions in solving problems on dynamics material seen from the aspects of problem solving are as follows:

- a. Aspects of understanding the problem, namely: students experience misconceptions in interpreting questions, misconceptions in interpreting pictures and their descriptions and misconceptions in analyzing questions. The reason is the students' reasoning is incomplete/wrong and students' abilities are low.
- b. Aspects of planning problem solving, namely: students' misconceptions in connecting between data to find the data they are looking for and misconceptions in connecting one concept to another. The cause of the misconception in this aspect is the students' humanistic thinking.
- c. Aspects of implementing a problem-solving plan, namely misconceptions in implementing inappropriate formulas and using inappropriate units. Misconceptions in this aspect are caused by incomplete or incorrect reasoning and students' humanistic thinking (Taqwa & Pilendia 2018).

The percentage of students' time effectiveness in solving problems can be seen in Table 3.

Table 3 Percentage of Student Time Effectiveness Results in Solving Dynamics Problems

Percentage	Frequency	Criteria
0%-20%	9	Very Ineffective
21%-40%	0	Weak/ineffective
41%-60%	1	Effective enough
61%-80%	30	Effective
81%-100%	2	Very effective
Average	85.75	

Based on the results of the effectiveness of understanding students' concepts in solving dynamics problems in seven SMAN Kab. Sigi has an average percentage of 85.75%, namely 37 students are in the effective category, 2 students are in the very effective criteria, 1 student is in the moderately effective criteria. and 9 students are in the very ineffective criteria. It is concluded that the effectiveness of students in solving dynamics problems has a very good level of effectiveness.

Students who are ineffective due to several factors, this is clearly seen when students fill out the questionnaire distributed in the google form, that students do not understand the material provided so that their understanding of concepts is low. These factors include:

a. Teaching method

Teaching method is a way or path that must be passed in teaching. If the teacher's teaching method is not good, it will affect student learning which is not good as well. Poor teaching methods can occur, for example, because the teacher lacks preparation and lacks mastery of the subject matter so that the teacher presents it unclearly or the teacher's attitude towards students and subjects is not good. to learn. Teachers usually teach by the lecture method only. Students become bored, sleepy, passive and only take notes and if the teacher is progressive and tries new methods, in order to help improve teaching and learning activities, and increase student motivation to learn. So that students can run well,

b. Study method

Research by several experts on learning style (learning style), learning outcomes do not depend on time absolutely, but depend on the choice of time that matches student readiness or student readiness in absorbing, managing and storing information that has been obtained. In the division of learning time, sometimes students study irregularly, so it is necessary for students to regularly every day, with good time division, choosing the right and sufficient way of learning will improve learning outcomes. The above greatly affects the effectiveness of students so that students do not understand the concepts given.

Conclusion

Based on the results of the analysis of the consistency of students' conceptual understanding using the FCI assessment, the percentage with the highest score was 90.5% of students' conceptual understanding. This is because students are able to describe answers in detail and systematically so that their answers are consistent between the choices and the reasons given. In the results of the analysis of the effectiveness of students' understanding of concepts, the average percentage is 85, 75% of 42 students. This is due to several factors such as good teaching and learning methods, so that students get good understanding results.

Acknowledgments

The researcher would like to thank all related parties who have supported and assisted in providing data and information for the purpose of this research.

References

- Adianto, T., & Rusli, MA (2021). Analisis Kesulitan Siswa dalam Menyelesaikan Soal Fisika: Topik Impuls dan Momentum. *Jurnal Pendidikan Sains Unnes*, 10(1), 24–33.
- Amin, Ramalis, T. R., & Efendi, R. (2017). Analisis psikometri instrumen force concept inventory (FCI) untuk menilai kemajuan belajar gaya dan gerak (KBGG). *Jurnal wahana pendidikan fisika*, 2(1), 5–10.
- Fatmawati, E. T., & Sujatmika, S. (2018). Efektivitas pembelajaran problem based learning terhadap hasil belajar ipa ditinjau dari kemampuan berpikir kritis. *Wacana Akademika*, 2(2), 163–171.
- Fiorella, L. (2020). Ilmu Kebiasaan dan Implikasinya terhadap Pembelajaran dan Kesejahteraan Siswa. *Tinjauan Psikologi Pendidikan*, 32(3), 603–625.
- Handhika, J., Huriawati, F., & Fitriani, N. (2017). Force concept inventory (FCI) representation of high school students (SMA & MA). *Journal of Physics: Theories and Application*, 1(1), 29–34.
- Hidayat, E. I. F., Yandhari, I. A. V., & Alamsyah, T. P. (2020). Efektivitas pendekatan realistic mathematics education (RME) untuk meningkatkan kemampuan pemahaman konsep matematika siswa kelas v. *Jurnal imiah sekolah dasar*, 4(1), 106–113.
- Jusriana, A., Wahyuni, A. S., & Rappe, M. (2019). Efektivitas model pembelajaran problem posing tipe post solution posing terhadap peningkatan pemahaman konsep fisika peserta didik. *Phydagogic: jurnal fisika dan pembelajarannya*, 1(2), 36–40.
- Kurniasari, A., Pribowo, F. S. P., & Putra, D. A. (2020). Analisis efektifitas pelaksanaan belajar dari rumah (BDR) selama pandemi covid-19. *Jurnal review pendidikan dasar: Jurnal kajian pendidikan dan hasil penelitian*, 6(3), 1–8.
- Melisari, M., Septihani, A., Chronika, A., Permaganti, B., Jumiaty, Y., & Fitriani, N. (2020). Analisis kesalahan siswa dalam menyelesaikan soal pemahaman konsep matematika sekolah dasar pada materi bangun datar. *Jurnal cendekia*, 4(01), 172–182.
- Munfaridah, N., Sutopo, S., Sulur, S., & Asim, A. (2017). Analisis miskonsepsi “gerak dan gaya” menggunakan instrumen force concept inventory (FCI) pada mahasiswa calon guru fisika. *LENSA (Lentera Sains): Jurnal pendidikan IPA*, 7(1), 66–75.
- Nadhor, N., & Taqwa, M. R. A. (2020). Pemahaman konsep kinematika mahasiswa calon guru fisika: Ditinjau dari level pemahaman dan teori resource. *PENDIPA Journal of Science Education*, 4(3), 82–90.
- Nawati, I., Saepuzaman, D., & Suhandi, A. (2017). Konsistensi konsepsi siswa melalui penerapan model interactive lecture demonstration pada materi gelombang mekanik. *Jurnal penelitian pembelajaran fisika*, 8(1), 32–38.
- Paramita, I., Yennita, & Fakhruddin, Z. (2018). Analysis of students scientific consistency and representation consistency on rectilinear motion kinematics material grade X in SMAN 8 Pekanbaru. *Jurnal geliga sains: Jurnal Pendidikan Fisika*, 6(1), 9–18.
- Pratiwi, FAI, Kuswanto, H., & Ariswan. (2025). Pemahaman Konseptual Siswa dalam Pembelajaran Fisika: Tinjauan Pustaka Sistematis. *Jurnal Ilmu Pendidikan Fisika*, 10 (1), 57–66.
- Rahmi, R., Atiq, A., & Hidasari, F. P. (2020). Efektivitas waktu pembelajaran penjasorkes pada kurikulum 2013 di SMA Negeri 2 Pontianak. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK)*, 9(1), 1-8.
- Safriana, S., & Fatmi, N. (2018). Analisis

- miskonsepsi materi mekanika pada mahasiswa calon guru melalui force concept inventory dan certainty of response index. *Jurnal pendidikan sains Indonesia*, 6(2),90–94.
- Saregar, A., Marlina, A., & Kholid, I. (2017). Efektivitas model pembelajaran arias ditinjau dari sikap ilmiah: Dampak terhadap pemahaman konsep fluida statis. *Jurnal ilmiah pendidikan fisika, Al-BiRuNi*, 06(2), 255–263.
- Taqwa, M. R. A., & Pilendia, D. (2018). Kekeliruan memahami konsep gaya, Apakah pasti miskonsepsi? *Jurnal inovasi pendidikan fisika dan integrasinya*, 01(02), 1–8.