PAPER NAME

4. Analysis of undergraduate students' c onceptual.pdf

WORD COUNT	CHARACTER COUNT
3433 Words	**18766 Characters**
PAGE COUNT	FILE SIZE
9 Pages	**659.5KB**
SUBMISSION DATE	REPORT DATE
Jun 24, 2023 12:09 AM GMT+8	**Jun 24, 2023 12:10 AM GMT+8**

9% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 2% Publications database
- 9% Submitted Works database
- Crossref Posted Content database

Excluded from Similarity Report

- Internet database
- Bibliographic material
- Cited material
- Crossref database
- Quoted material
- Small Matches (Less then 8 words)

Journal of Physics: Conference Series

PAPER • OPEN ACCESS

Analysis of undergraduate students' conceptual understanding of magnetism topics

To cite this article: P Palloan *et al* 2019 *J. Phys.: Conf. Ser.* **1317** 012165

Analysis of undergraduate students' conceptual understanding of magnetism topics

P Palloan[*], A Azis, A Haris, and A Hakim

Physics Department, Universitas Negeri Makassar, Jl. Daeng Tata Raya, Makassar, Indonesia

* pariabty.p@unm.ac.id

Abstract. Research in physics education has long been concerned with a problem that undergraduate students acquire conceptions which are unsatisfactory from the scientific point of view. It is very important for educators to review further how strongly the conception is held in various domains of physics. Learning about magnetism is an important component of physics science education, thus requiring deeper analysis of understanding concepts. This research objectives to reveal the conceptual understanding about magnetism topics of undergraduate students. This research was a descriptive study to analysis 32 first year undergraduate student test results of conceptual understanding in Physics Department of State University of Makassar, South Sulawesi. The research data was obtained through technical test. These questions consists of 20 sets of question. It is has been developed by researcher and validated by experts. The result showed that only 40,9% undergraduate students understood about magnetism concept, 30,9% is just guessed, and 28,1% don't understood. These result is still relatively low, considering the questions given are still very basic, and have not linked to the Maxwell equation. These results can be used as basic for determining the appropriate learning which is suitable for student in understanding Physics context as basis for entering electrodynamics courses.

1. Introduction

Science educators recommend conceptual and qualitative physics, the idea that physics should be taught not only through by mathematical formulas and interpretations, but rather through projects, experiments, labs, demonstrations, and visualization media that help students understand conceptually physical phenomena [1–4]. Physics Education Research (PER) has shown that the concept of pre-instructional physics undergraduate students contrary to the conception of physics to be studied [5]. Most educators agree that the teaching of science, especially physics, must move away from a system that promotes science, especially as recall of factual information and rote computation to one which emphasizes conceptual understanding, logical and science process skills [6]. Many domains of physics deal with abstract and multidimensional phenomena that difficult to understand. Abstract physics concepts requires students to build mental models that are flexible and testable [7].

Adjusting the understanding of student's physics concepts with the applied curriculum is done by analysing the conceptual understanding. Researcher and educators try to find dimensions and everything that can support conceptual understanding of undergraduate students. Dimensions of conceptual understanding were identified into several aspects of knowledge, namely factual and procedural knowledge, connections, transfer, and metacognition, and misconceptions [8]. Information professionals who train others (e.g. educators, teachers) can use Bloom's taxonomies to write learning goals that describe the skills and abilities, distinguish between levels of cognitive skills and lead to deeper learning and transfer of knowledge and skills to a various tasks and contexts wider [9,10]. One aspect of the cognitive domain proposed by Benyamin S Bloom is understanding (*comprehension*) [10]. Bloom states that understanding is when students are faced with a communication and can use the ideas contained in it. The communication in question can be in verbal or written form in verbal or symbolic form [10–12]. Students are required not to be limited to remembering or recalling lessons, but able to define, as an indication that students have understood the subject matter. In cognitive domain of Bloom's taxonomy, understanding is a higher level than knowledge. Bloom divides understanding into three aspects, namely translation, interpretation, and extrapolation [10,11]. A concept is an abstract state that represents an object class of events, activities, or relationships that have the same attributes. Therefore, people experience difference stimuli, people form concepts are abstractions based on experience and because no two people have exactly the same experience, the concepts that people form are different [13,14].

The demands to be a real physicist, undergraduates students are required to develop an accurate scientific mental model but do not have references that are familiar in real life, including something invisible and so complex [15]. For example, in the sub-field of electromagnetism, need three-dimensional representation, very abstract, and has a little analogy with the daily experiences of students [3,16,17]. Undergraduate students have some difficulties understanding the abstraction relationship about electric and magnetic fields with phenomenological dynamics [3,16,18–20]. Universities using curricula which introducing the study of Physics (Fundamental of Physics, include magnetism matter) at the beginning of the curriculum so that students have a deeper conceptual understanding of magnetism that can be used to understand complex electricity and magnetism course, e.g. Maxwell's equations. So, we need a deeper analysis of conceptual understanding of magnetism. These results can be used as a basis for determining the appropriate learning for undergraduate students.

2. Experimental

This research has used a descriptive study to analyse Conceptual Understanding of the 32 undergraduate students in one of the Physics Department of State University of Makassar, South Sulawesi. The subject chosen are first year undergraduate students who are programming basic physics courses. Data collection is done once. This is a survey research with samples determined by purposive sampling technique. The research instrument used in the form of multiple choices are accompanied by reasons for answering. The number of questions tested was 20 questions with 5 answer choices along with the reason to answer. Instrument tested has a similar form the research that has been done, but for different physical matter [21–23].

Table 1. Distribution of sub-topics in Instrument

Sub Topics	Number of Question
Magnetic Field	1, 3, 4, 5, 6, 13
Magnetic Force	2, 7, 8, 9, 10, 11, 12, 17, 18, 19, 20
Induced current	14, 15, 16

The magnetic subject matter to be tested is grouped into 3 subtopics, namely: Magnetic field, Magnetic force, induced current. Distribution of subtopics in Instrument can be seen in table 1. The percentage level of understanding is grouped into several categories as shown in table 2. Furthermore, to find out the criteria for students' answer to the concepts, students guess and students do not understand the concepts in the answer can be seen in understanding the concept, students guess, and students do not understand the concept of the answer can be seen in table 3.

Table 2. Percentage of Level Understanding

No	Percentage	Category
1	≤ 30 %	Low
2	30 % ≤ x ≤ 60 %	Medium
3	61 % - 100 %	high

Table 3. Criteria for Understanding Concepts, Guessing, and Not Understanding Concepts

No	Question	Answer	Category
1	Multiple Choices	Correct	Understanding Concept
	Reason	Correct	
2	Multiple Choices	Correct	Guessing
	Reason	Wrong	
3	Multiple Choices	Wrong	Guessing
	Reason	Correct	
4	Multiple Choices	Wrong	Not Understanding Concept
	Reason	Wrong	

3. Result and Discussion

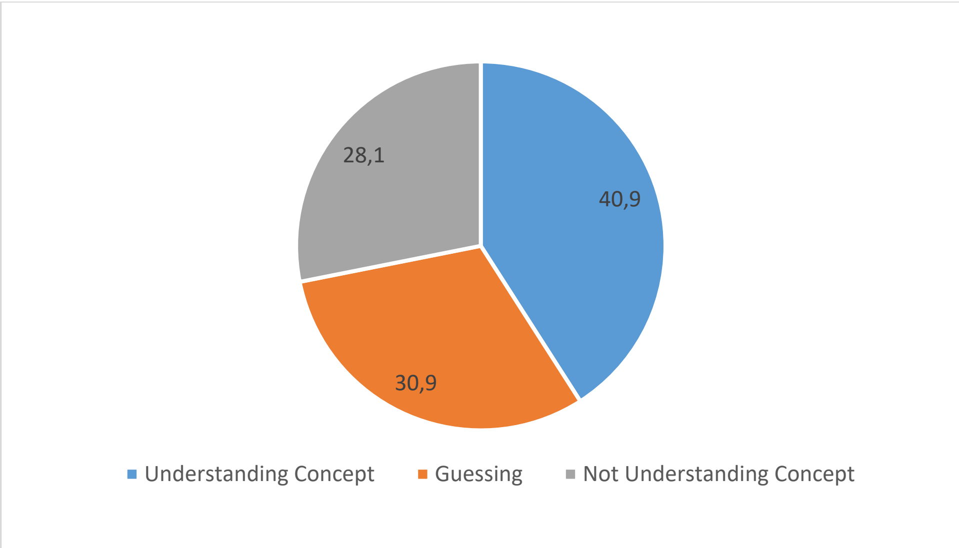


Figure 1. Percentage of Conceptual Understanding

The results showed that students' conceptual understanding of magnetic topics was in the medium category. The percentage of students who understood the concept was 40.9%, the average percentage of students who guessed was 30.9%, and did not understand the concept 28.1%. These results can be seen in Figure 1.

The categories of conceptual understanding of magnetic topic for each sub-topics is shown in figure 2. It can be seen that subtopic that have the most understood by undergraduate students is magnetic field topic, with a percentage 43,23 % (medium category), while the least understood by students is Induced current, with percentage 36,46% (medium category).

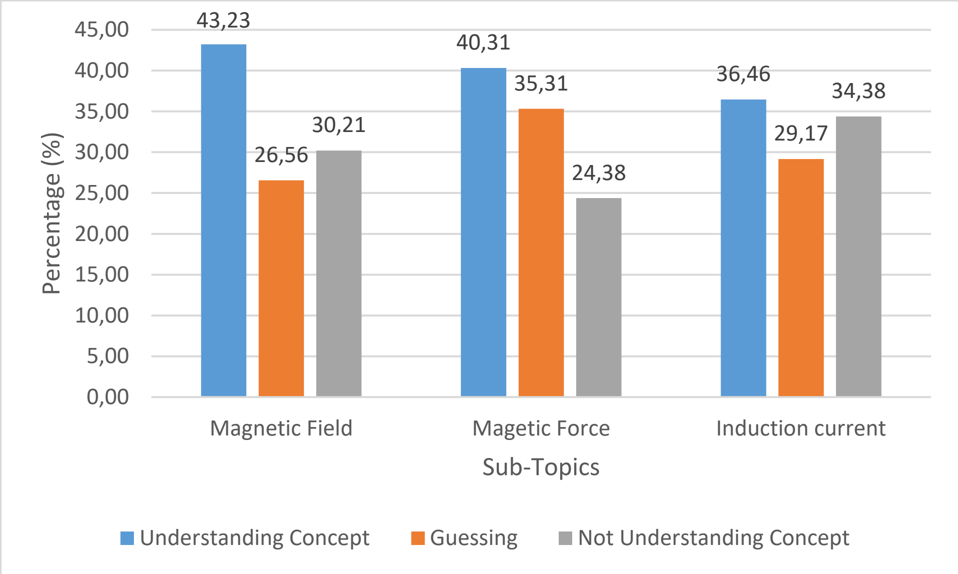


Figure 2. Understanding Concepts, Guessing, and Not Understanding Concepts for Each Magnetic Sub-topic

Students most often guess at subtopic magnetic force with percentage 35,31% , while students least guess at subtopic magnetic field with percentage 26,56%. Students have the lowest conceptual understanding in subtopic Induced current with percentage, whether it is seen from the level of understanding of the concept or from the percentage of students who do not understand.

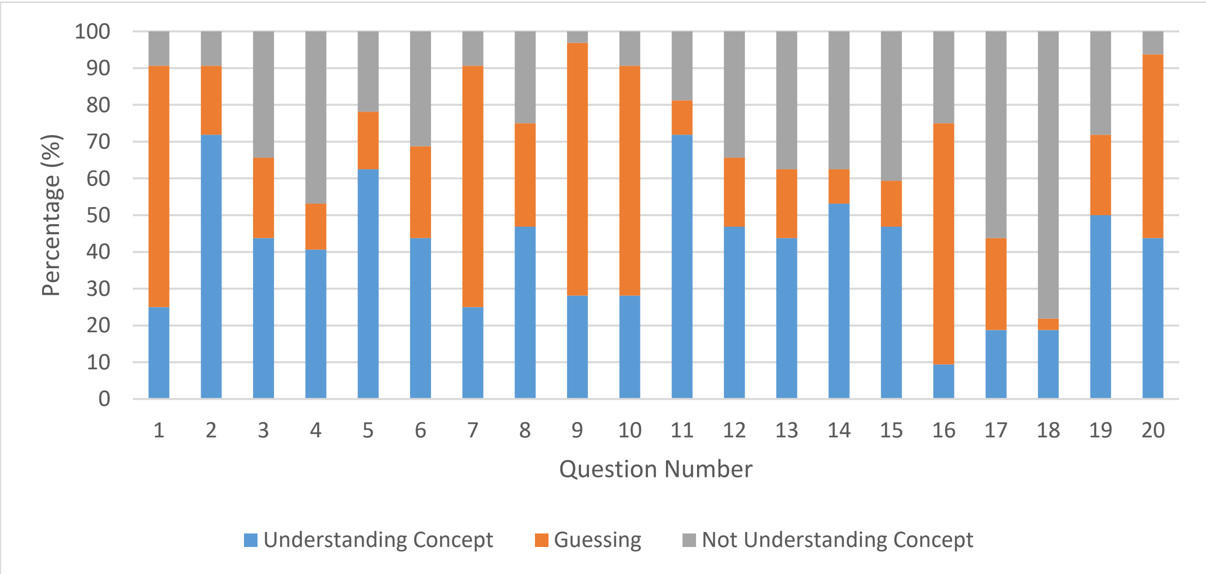


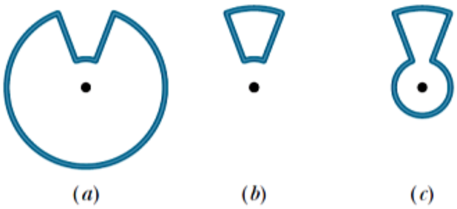
Figure 3. Distribution of Conceptual Understanding of Each Question

Based on figure 2 and 3, it be seen that undergraduate students are very often guessing on sub-topic magnetic force, most students give inappropriate force directions. The following is full explanation for each sub-topics:

3.1 Magnetic field

This subtopic discusses how the magnetic field characteristics are generated from various types of current states that produce it, such as the direction of the magnetic field when viewed from the direction of current that produces it, and how the shape arrangement of wires can influence the magnitude of magnetic field. One example of the problem for the problem for the topic of the magnetic field being tested can be seen in the figure 4 below.

The figure below consists of three circuits, each consisting of two straight radial wires and two concentric circular arc wires, with a radius of r and R, where $R > r$. Each circuit flows the same current and the angle between two straight radial wires is equal. The sequence based on the magnitude of the magnetic field produced at the midpoint is ... (from the biggest)



a. (c) – (a) – (b)
b. (a) – (c) – (b)
c. (b) – (c) – (a)
d. (b) – (a) – (c)
e. (c) – (b) – (a)

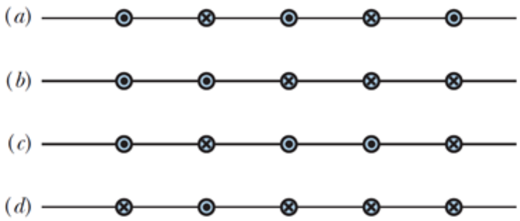
Figure 4. A sample question for subtopic magnetic field

Determining the right direction for magnetic field produced by a wire arrangement flowing by a certain current will always be a problem for students. Most students only see that, if wire used is longer (without seeing the distance from current wire to the point of review), the magnetic field produced will also be greater. This problem is caused by the low understanding of students in interpreting cross-multiplication operator in the Biot-Savart Law equatio, so that students are always wrong to determining a magnetic field that weakens or strengthens each other at a point that is reviewed. These results are consistent with several studies that have been conducted that students always have dificulity understanding field vector in space [3,17,24]

3.2 Magnetic force

This subtopic discusses how the force to a charge (a single in a particle, or the charge that flows in a wire) moves in particular magnetic field. One example of the problem for the problem for the topic of the magnetic field being tested can be seen in the figure 5 below.

The figure below shows 4 types of arrangement consisting of 5 long straight wires parallel to each other. Each wire carries a current of equal magnitude but the direction varies (out of the paper plane or through the paper plane). The sequence of wires arrangement that produces magnetic force on the middle wire due to other wires is ... (from the largest)



a. (d) - (c) - (b) - (a)
b. (b) - (d) - (c) - (a)
c. (a) - (c) - (d) - (b)
d. (c) - (b) - (a) - (d)
e. (c) - (d) - (b) - (a)

Figure 5. A sample question for subtopic magnetic force

Force is a vector quantity, so understanding vector is the main capital to understanding this physical topic. Understanding of students that perceive force can only be given through direct contact, this kind of understanding makes students confuse "*what kind of force that can work on an object if it doesn't touch it.*" An analogy about the gravitational field can lead students to understand this. But again, the direction of force given is always a problem for students because of low understanding of cross-multiplication in Lorentz force equation, and they cannot visualize or imagine the distribution of forces in all vector field to determine how a test charge moves, or even understand the concept of force that change with distance from reference point [3,25].

3.3 Induced Current

This sub-topic discusses the current in the wire caused by the magnetic field situation around it. If a wire roll is placed in a magnetic field that is always changing, a current will be induced in the wire. This current arises due to the electric field formed and then forces the charge in the wire to flow, (this force is not the result of magnetic force because the charge is initially stationary). This "force" is called an electromotive force, or "*emf*" (electromotive force), even though it is not a force. Electromotive force is basically the voltage produced by the battery. The magnetic field that changes through a wire coil must have an electric force in the coil which in turn causes current to flow. One example of the problem for the problem for the topic of the magnetic field being tested can be seen in the figure 6 below.

Below are some of the quantities related to magnetic induction
(1) Number of coil turns
(2) The rate of change in magnetic flux
(3) Large magnetic induction
What affects the EMF (electromotive motion) induction in the generator is ...

a. (1)
b. (1) and (2)
c. (1), (2), and (3)
d. (2) and (3)
e. (3)

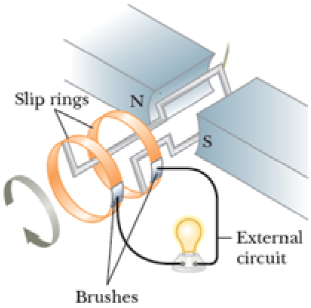


Figure 6. A sample question for subtopic magnetic force

Students always separate the change component of the magnetic field in *emf* equation ($\varepsilon = NBA \sin \omega t$), so they confuse the trigonometric component signifying a change variable. Students answer a questions without linking the concept of magnetic flux, they see that *emf* increases if the magnetic field is large, and not because of changes in the magnetic field itself, so that the understanding of students in interpreting the symbol of "delta" or differential in equation needs to be emphasized. Or even better if students can get the equation through a simple experiment using an electric motor or a simple simulation [3,4,16].

Strengthening various basic concepts in physics is needed before entering magnetic material. This result is still not enough, considering that the basic concept of magnetic is very necessary to explore electrodynamics courses that are much heavier, and are filled with non-simple calculus, which is used in describing and understanding Maxwell equations. The more abstract physical matter being taught, the opportunity to make it familiar and contextual in the learning process. Maybe this is not so necessary if students can do research-based learning, but it cannot be denied that it is sometimes difficult to do, especially students who are very ordinary. Educators will always determine the course of learning that is most appropriate for a class, not just for some students.

Not every educational institution has equipment that can show in real terms how a magnetic field works, how the charge moves in a magnetic field, and how the current is generated through magnetic fields, we can only observe how the impact is without seeing the process directly. This is what makes the magnetic concept still difficult to teach [1,4,16,17,25,26]. However, actually these weaknesses are not an obstacle, rapid technological development and every side of students' lives that are always accompanied by smart devices provides great opportunities for educators in using simulation software, it is not emphasized to be a media developer, considering that many have experienced it, an educator should only technological literacy in order to take advantage of all these opportunities.

4. Conclusion

The result showed that only 40,9% undergraduate students understood about magnetism concept, 30,9% is just guessed, and 28,1% don't understood. These result is still relatively low, considering the questions given are still very basic, and have not linked to the Maxwell equation. These results can be used as basic for determining the appropriate learning which is suitable for student in understanding Physics context as basis for entering electrodynamics courses. It would be nice if physics (or other abstract science materials) is taught not only through mathematical formulas, but through scientific projects, experiments, labs, demonstrations, or visualizations that help students understand conceptually abstract phenomena.

Acknowledgments

The author is very grateful to undergraduate students and lecturer team at our research team at the State University in Makassar, who have given us permission and convenience during the research.

References

[1] DiSessa A A 2001 *Changing Minds: Computers, Learning, and Literacy* (London: The MIT Press)
[2] Hewitt P G 2014 *Conceptual Physics* (New Jersey: Pearson Education)
[3] Squire K, Barnett M, Grant J M and Higginbotham T Electromagnetism Supercharged! Learning Physics with Digital Simulation Games 8
[4] Forbus K D 1997 Using qualitative physics to create articulate educational software *IEEE Expert* **12** 32–41
[5] Brown D E and Hammer D 2013 Conceptual Change in Physics *International Handbook of Research on Conceptual Change* (Routledge)
[6] Saleh S 2011 The Level of B.Sc.Ed Students' Conceptual Understanding of Newtonian Physics *International Journal of Academic Research in Business and Social Sciences* **1** 8
[7] Barab S A, Hay K E, Barnett M and Keating T 2000 Virtual solar system project: Building understanding through model building *Journal of Research in Science Teaching* **37** 719–56
[8] Mills S 2016 Conceptual Understanding: A Concept Analysis **21** 546–57
[9] Adams N E 2015 Bloom's taxonomy of cognitive learning objectives *Journal of the Medical Library Association : JMLA* **103** 152–3
[10] Bloom B S 1956 *Taxonomy of educational Objectives: The Classification of Educational Goals* (New York: Longman Green)
[11] Anderson L W 2000 *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (New York: Pearson)
[12] Marzano R J and Kendall J S 2007 *The New Taxonomy of Educational Objectives* (New Delhi: Sage Publications India)
[13] Vinner S 1983 Concept definition, concept image and the notion of function *International Journal of Mathematical Education in Science and Technology* **14** 293–305
[14] Vinner S and Dreyfus T 1989 Images and Definitions for the Concept of Function *Journal for Research in Mathematics Education* **20** 356
[15] Chi M T H, Feltovich P J and Glaser R 1981 Categorization and Representation of Physics Problems by Experts and Novices* *Cognitive Science* **5** 121–52
[16] FuriO C and Guisasola J 1998 Difficulties in learning the concept of electric field *Science Education* **82** 511–26
[17] Roussel H and Hélier M 2012 Difficulties in teaching electromagnetism: an eight year experience at Pierre and Marie Curie University *Advanced Electromagnetics* **1** 65
[18] Chambers S K and Andre T 1995 Are Conceptual Change Approaches to Learning Science Effective for Everyone? Gender, Prior Subject Matter Interest, and Learning about Electicity *Contemporary Educational Psychology* **20** 377–91

IOP Conf. Series: Journal of Physics: Conf. Series **1317** (2019) 012165 doi:10.1088/1742-6596/1317/1/012165

[19] Sağlam M and Millar R 2006 Upper High School Students' Understanding of Electromagnetism *International Journal of Science Education* **28** 543–66

[20] Anon 2017 Mathematics Knowledge, Physics Performance, Electromagnetism *International Journal of Theoretical and Mathematical Physics* 7

[21] Heckler A F and Scaife T M 2015 Patterns of Response Times and Response Choices to Science Questions: The Influence of Relative Processing Time *Cognitive Science* **39** 496–537

[22] Timmermann D and Kautz C 2015 Multiple Choice Questions that Test Conceptual Understanding: A Proposal for Qualitative Two-Tier Exam Questions *2015 ASEE Annual Conference and Exposition Proceedings* 2015 ASEE Annual Conference and Exposition (Seattle, Washington: ASEE Conferences) pp 26.1179.1-26.1179.15

[23] Barniol P and Zavala G 2014 Test of understanding of vectors: A reliable multiple-choice vector concept test *Physical Review Special Topics - Physics Education Research* **10**

[24] Ibáñez M B, Di Serio Á, Villarán D and Delgado Kloos C 2014 Experimenting with electromagnetism using augmented reality: Impact on flow student experience and educational effectiveness *Computers & Education* **71** 1–13

[25] Dede C, Salzman M C, Loftin R B and Sprague D 1999 Multisensory Immersion as a Modeling Environment for Learning Complex Scientific Concepts (Springer New York) pp 282–319

[26] Dori Y J and Belcher J 2005 Learning Electromagnetism with Visualizations and Active Learning *Visualization in Science Education* ed J K Gilbert (Dordrecht: Springer Netherlands) pp 187–216

9% Overall Similarity

Top sources found in the following databases:

- 2% Publications database
- Crossref Posted Content database
- 9% Submitted Works database

TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	Universitas Diponegoro on 2019-11-09 Submitted works	5%
2	West Coast University on 2021-11-28 Submitted works	3%
3	National University of Singapore on 2022-03-25 Submitted works	<1%
4	Syiah Kuala University on 2023-06-14 Submitted works	<1%
5	Milpitas High School on 2012-05-22 Submitted works	<1%
6	University of Birmingham on 2018-01-08 Submitted works	<1%
7	University of South Africa on 2012-09-04 Submitted works	<1%