JPPIPA 8(2) (2022)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Identify Hydrostatic Misconceptions Using Four Tier Diagnostic Tests with the Help of iSpring Suite 9 (Case Study in UNIS Faculty of Engineering Students)

Febri Rismaningsih[1*], Asri Nurhafsari[1]

[1] Faculty of Engineering, Universitas Islam Syekh-Yusuf, Tangerang, Indonesia.

DOI: 10.29303/jppipa.v8i2.1290

Article Info
Received: January 4, 2022
Revised: April 18, 2022
Accepted: April 22, 2022
Published: April 30, 2022

Abstract: The study aims to identify students' misconceptions about hydrostatic concepts using the Four-Tier Diagnostic Test with the help of iSpring Suite 9. The methods used in this study are quantitative descriptive. The population in this study are all students of Strata 1 of the Faculty of Engineering of Universitas Islam Syekh-Yusuf who are studying Basic Physics. Sampling in this study through purposive sampling techniques that are subjective where the selection of samples is based on the consideration of the lecturer researcher concerned. Based on expert validation from the four-tier diagnostic test assisted iSpring Suite 9, it can be concluded that the instruments that have been developed are suitable for use for research. The reliability of the question is calculated using the Alpha Cronbach coefficient and a reliability value of 0.93 is obtained. This shows that the questions used in the research are reliable. The results of the study, which identified student misconceptions regarding hydrostatics, can be concluded that there are still many students who experience misconceptions with a percentage of 70.21% on the concept of hydrostatic pressure, 40.43% on Pascal law concept, 42.55% on the concept of Archimedes law. 46.81% on the concept of surface tension and 34.04% on the concept of capillarity. The percentage of overall misconceptions on the concept of hydrostatics falls into the high category.

Keywords: Misconception; Hydrostatics; Four Tier Diagnostic Test; iSpring Suite 9

Citation: Rismaningsih, F., & Nurhafsari, A. (2022). Identify Hydrostatic Misconceptions Using Four Tier Diagnostic Tests with the Help of iSpring Suite 9 (Case Study in UNIS Faculty of Engineering Students). *Jurnal Penelitian Pendidikan IPA*, *8*(2), 773–780. https://doi.org/10.29303/jppipa.v8i2.1290

Introduction

The most common problem found in lectures, especially Basic Physics, is the low understanding of concepts. Based on the results of interviews with some students, the difficulty experienced is when it comes to understanding and explaining abstract concepts, especially accompanied by complex mathematical formulas. This is what causes some students to assume for themselves about the material studied so that misconceptions arise. Misconceptions are defined as misunderstandings and interpretations that are not scientifically accurate, showing inaccurate prior insight and wrong ideas (Cooper & Klymkowsky, 2013). (Hikmawati & Sutrio, 2019) explained that misconception is a term to indicate the circumstances in which a person believes the concept he has is correct but in fact the concept is wrong according to the determination of experts (Çelikten et al., 2012). In formal education, scientific misconceptions have been found through interactions between lecturers and students who may experience misconceptions in learning process (Soeharto & Csapó, 2021). Misconceptions that occur can interfere with understanding in the next learning process (Hidayati et al., 2013). so this is where the role of lecturers to identify the cause of the misconception.

Student misconceptions are difficult to identify with traditional methods. Educators have to revise and

* Corresponding Author: frismaningsih@unis.ac.id

identify student misconceptions to help students understand new concepts and finally provide opportunities for students to apply these concepts to science problems (Butler et al., 2015). There are several ways to find out misconceptions in students, one of which is the use of diagnostic tests. To evaluate and identify students' basic knowledge of concepts in science, researchers used a diagnostic test. The diagnostic test assesses students' proportional knowledge on the basis of the science content, the science teacher can develop a clear idea about the nature of the students' knowledge by using a diagnostic test at the beginning or the end of the learning activity (Taslidere, 2016). A good diagnostic test can provide an accurate picture of the misconceptions experienced by students based on the error information they make. A good diagnostic question not only shows that students do not understand a particular piece of material, but can also show how students think in answering a given question even if their answer is incorrect (Law &Treagust, 2010) quoted from (Rusilowati, 2015). Various types of instruments have been used in science education to identify misconceptions including interviews, open-ended questions, concept maps and multiple-choice tests (Caleon & Subramaniam, 2010; Djanette & Fouad, 2014; Chen et al., 2013) all of which have advantages and disadvantages in their use (Gurel et al. 2015). In the development of diagnostic tests began with the Two-Tier Test. In this test, there are two tiers and the first tier of each item consists of a multiple-choice question includes content knowledge (Mutlu & Sesen, 2015) but this instrument still has the disadvantage that the results obtained are too high (overstimate) in identifying misconceptions, because all wrong answers are considered misconceptions (Kaltakci-Gurel et al., 2017). Furthermore, the weaknesses in the Two-Tier Test are improved by the emergence of the Three-Tier Test,this instrument of difference lies in the addition of the level of confidence placed after the first two levels with the aim of ensuring the student's confidence in answering questions in the previous two levels (Arslan et al., 2012). Nevertheless, the Three-Tier Test has not been fully able to identify misconceptions despite being able to validly measure error-free misconceptions and Lack of Knowledge (LK). This instrument has limitations related to confidence levels for tiers 1 and 2 (Gurel et al., 2015). *The four-tier test* present adds two levels of confidence that lie to the question tier and the reason tier. This diagnostic test instrument is stated to be more aware of the condition of understanding learners (Kaltakci-Gurel et al., 2017).

The advantages of the Four-Tier diagnostic test as research conducted by (Fariyani et al., 2015) include teachers being able to distinguish the level of answer confidence and the level of belief of the reasons chosen by students so that they can dig deeper into the power of understanding student concepts, diagnose misconceptions experienced by students more deeply, determine the parts of the material that require more emphasis, and Plan better learning to help reduce student misconceptions. Existing research is developing diagnostic test instruments in the form of paper-based tests and web-based. However, the study used an android-based diagnostic test, the iSpring Suite 9 app with the Four-Tier diagnostic Test. iSpring Suite 9 is an additional application for PowerPoint, where iSpring Suite 9 is able to convert a presentation (PPT/PPS) into SWF (Shockwave Flash) (Ninawati et al., 2021). The Ispring Suite app has a variety of features that can be used to create presentations, quizzes, surveys, interactive conversation simulations, and student worksheets (Dasmo et al., 2020). Through iSpring Suite 9 is able to foster motivation and provide direct experience to students in studying IPA (Physics) materials that tend to be abstract, thus affecting the improvement of student learning outcomes (Purnama Sari & Ridwan, 2020).

Hydrostatics is one of the basic physics course concepts that are closely related in everyday life but many cause misconceptions (Zulfa et al., 2017). Research on the identification of misconceptions at the student level is considered indispensable as the basis for the design of lectures. Through this research is expected to provide an overview of the understanding of student concepts on the concept of hydrostatics so that later can be developed the right methods to improve the quality of basic physics learning.

Method

The research method used is a descriptive method. Descriptive research methods are one type of research that aims to investigate circumstances, conditions, situations, events, activities, and others in full (Arikunto, 2013). This method is done to find out the real picture without doing treatment to the understanding of the student concept on the concept of hydrostatics. In this study, data was collected based on the results of the Four Tier Diagnostic Test (4TDT) with the help of iSpring Suite 9 which was then described according to the actual circumstances. The population in this study is all students of Strata 1 Faculty of Engineering at Universitas Islam Syekh Yusuf a sample of 47 students who are studying basic physics. Sampling in this study through a subjective pusposive sampling technique where the selection of samples is based on the consideration of the lecturer researcher concerned.

This research consists of several stages including research preparation, the manufacture of first-level instruments (tier 1), the manufacture of reason level instruments (tier 2), diagnostic test instrument trials, the creation of four tier diagnostic tests assisted by iSpring

Suite 9 and data processing and analysis. This study used the question of multiple choice that has four levels then modified by adding two levels of confidence in answering questions that are placed separately after the answer tier as the second tier and after the reason tier as the fourth tier. The research instrument was adapted from (Septiyani & Nanto, 2021) , which developed a four-tiered diagnostic test to identify students' misconceptions on temperature and heat matter.

Before the instrument is used, calibration is first carried out to test the feasibility of the instrument which includes validity, reliability, differentiating power and test the difficulty level of problem items that all use ANATES Software. Anates is highly recommended for teachers to use in analyzing the validation of problem items or tests so that the evaluation tools used are appropriate and effective (Ariany & Al-Ghifari, 2018). To validate the instrument, it requires the help of material experts to see the suitability of the contents with indicators as well as media experts to see the appearance of iSpring Suite 9 that has been created. The stages can be seen in the following image.

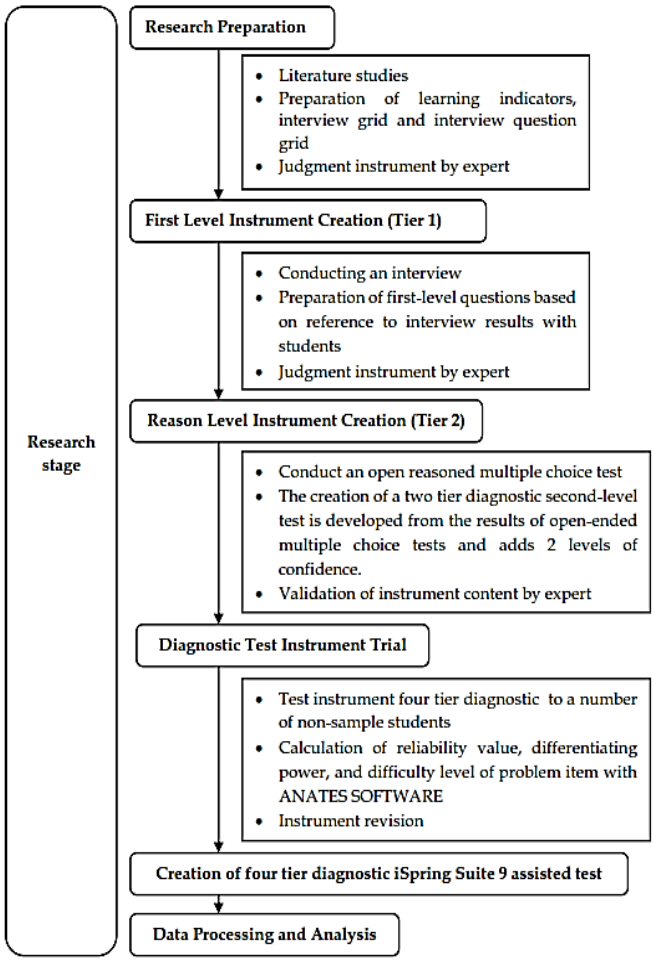

Figure 1. Research stages to identify hydrostatic misconceptions using four tier diagnostic test with the help of iSpring Suite 9

Interpretation of four-tier diagnostic test results is used to group students in criteria of understanding, disconction or misconception. The results of interpretation are made in the form of tables, containing answer columns, belief levels of answers, reasons, belief levels of reasons and criteria (Sulistiawarni, 2018). The interpretation given by respondents according to (Kaltakci-Gurel et al., 2017) on the Four-tier diagnostic test is shown in the following table.

Tabel 1. Interpretation of respondents on the four-tier diagnostic test

First tier	Second tier	Third tier	Forth tier	Category
Correct	Sure	Correct	Sure	Scientific
Correct	Sure	Correct	Unsure	Knowledge
Correct	Unsure	Correct	Sure	Lack of knowledge
Correct	Unsure	Correct	Unsure	Lack of knowledge
Correct	Sure	Incorrect	Sure	False Positive
Correct	Sure	Incorrect	Unsure	Lack of knowledge
Correct	Unsure	Incorrect	Sure	Lack of knowledge
Correct	Unsure	Incorrect	Unsure	Lack of knowledge
Incorrect	Sure	Correct	Sure	False Negative
Incorrect	Sure	Correct	Unsure	Lack of knowledge
Incorrect	Unsure	Correct	Sure	Lack of knowledge
Incorrect	Unsure	Correct	Unsure	Lack of knowledge
Incorrect	Sure	Incorrect	Sure	Misconception
Incorrect	Sure	Incorrect	Unsure	Lack of knowledge
Incorrect	Unsure	Incorrect	Sure	Lack of knowledge
Incorrect	Unsure	Incorrect	Unsure	Lack of knowledge

The percentage of students is grouped into categories of scientific knowledge, false positive, false negative and misconceptions calculated by the formula:

$$p = \frac{f}{N} \times 100\% \quad \text{..... (1)}$$

Where, p = percentage number (per group), f = Number of students of each group of each question and N = Number of students who are subject to research (Sarlina, 2015).

Based on the results of percentage calculations in accordance with the level of student understanding, as well as identifying in what subconceptions students experience misconceptions. Some categories of misconceptions based on the percentage magnitude can be seen in the table 2.

Table 2. Category of misconceptions based on percentages

Category	%
High	$61 - 100$
Medium	$31 - 60$
Low	$0 - 30$

(Suwarna, 2013)

Result and Discussion

Based on data processing, the tests used in this study had a realibility value of 0.93 and included realibility in very high categories. Of the 42 questions on the initial problem grid, the problem that passed the reliability and differentiating power test was as many as 35 questions. The distribution of four tier diagnostic tests on each material can be seen in the following table.

Table 3. The distribution of four tier diagnostic test

No.	Subject Matter
1	Hydrostatic Pressure
2	Pascal's Law
3	Archimedes' Law
4	Surface Tension
5	Capillary
6	Viscosity

Details of diagnostic tests that have been tested and valid are then made into the iSpring Suite 9 application so that the work link can be distributed to students. Each problem is given time to work, the time is adjusted to the difficulty level of the problem (1-2.5 minutes), while for the confidence level is given time to work for 10 seconds. The following is given an example of a view of the problem from iSpring Suite 9.

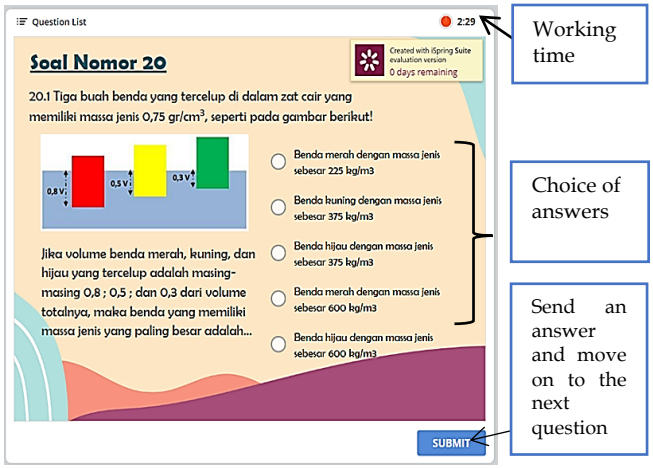

Figure 2. Question view 20.1 in iSpring Suite 9

Based on student answer patterns, data processing is carried out so that the percentage of student understanding categories is obtained on hydrostatic tests seen from each subconception as shown in Figure 3.

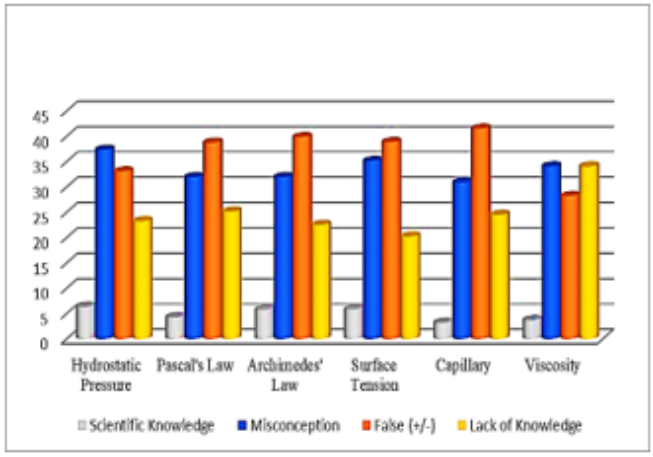

Figure 3. Percentage of student understanding level in each subconception

Almost from every hydrostatic subconception there are students who experience various misconceptions. Details of student answer categories and misconceptions that occur per subconception tested are seen in the discussion below.

Hydrostatic Pressure

The subconception of hydrostatic pressure in this instrument consists of 13 questions, namely problem number 1 to problem number 13. Of these 13 questions, students experienced the most misconceptions on problem number 7 with indicators of analyzing the formulation of hydrostatic pressure equations to determine the type of pressure.

The findings found a misconception of 70.21%, students consider that the pressure that occurs at a depth of 100 meters below sea level of 11.3 x 10^5 Pa is hydrostatic pressure. The right answer is absolute pressure because seawater can be considered like an open container, so its atmospheric pressure is included in the calculation of absolute pressure. Absolute pressure is determined based on absolute pressure, therefore at absolute pressure then for atmospheric pressure is expressed 1 atmosphere (absolute) or 0 atmosphere (gauge) (Ariyanto, 2021). The cause of the misconception in this number is due to a lack of ability to think and focus on understanding a problem in order to make precise conclusions. The cause is due to the lack of quality reading resources where the role of references such as teaching books is needed in order to support the achievement of competencies that are the purpose of learning (Rusilowati, 2014).

Pascal's Law

Pascal's Law subconception consists of 5 questions, of the 5 questions students experience the most misconceptions on problem number 16 with indicators of sorting correct statements related to Pascal's Law.

The results of misconception findings of 40.43%, students concluded that the correct statement is i and iv where (i) the force on the hydraulic jack on a small piston is proportional to the force on the hydraulic jack on a large piston then (iv) The change in height on a large piston is higher than the small piston after being exerted pressure from a small piston. The correct answer is (i) and (ii) i.e. (i) the force on the hydraulic jack on a small piston is proportional to the force on the hydraulic jack on the large piston then (ii) the surface area on the two different pistons. The majority of students are correct to choose (i) but are fooled by the choice (iv). This is because students still do not fully apply knowledge in relevant contexts to everyday life (Imansari et al., 2018)

Archimedes' Law

The subconception of Archimedes law consists of 7 questions, of the 7 questions students experience the most misconceptions on the number 19 and 25 of 42.55%, respectively. Problem number 19 with indicators about analyzing to find out the volume needed to lift weights on balloons obtained the finding that the majority of students have answered correctly that the volume of helium needed to be able to fly the hot air balloon is 448.7 m^3. (Air mass = 1.293 kg/m^3) where the total load that can be lifted by a balloon is 500 kg. If the balloon will be filled by helium gas that has a density of 0.1786 kg/m^3. However, the wrongly chosen reason is the load mass × the mass of helium = the mass of air transferred so that the volume of air transferred (V_{air}) is the sum of the volume of helium that fills the balloon (V_{helium}). While the reason for the right answer is the load mass/helium mass = the mass of air moved so that the volume of air transferred (V_{air}) = The volume of helium that fills the balloon (V_{helium}).

On the question number 25 with indicators about categorizing phenomena whose working principles use the concept of Archimedes law obtained the results of the findings that when students are given a problem to calculate the value of Volume, if a wooden beam with a mass of 7.5 kg and volume V is tied to the base of a tank containing water (ρ_{water} = 1.0 x 10^3 $kg.m^3$) so that the beam sinks entirely. The majority of the rope voltage is 25 N. The majority of students answer by using the formula in a balanced state then apply $T - w = F_A$ so that $T - m \cdot g = \rho_f \cdot V_T \cdot g$ thus the value of V can be determined. The right answer is that in a balanced state then $T + w = F_A$ applies to $T + m \cdot g = \rho_f \cdot V_T \cdot g$ thus the value of V is obtained 0,01 m^3.

The misconceptions in numbers 19 and 25 are because students are more likely to memorize a concept than analyze and then try to practice working on a problem. This is in keeping with the theory that students are better at memorization than science process skills. Students master more knowledge by memorizing not because of the way of thinking to get knowledge (Rusilowati, 2014).

Surface Tension

The subconception of surface tension consists of 4 questions, of the 4 questions students experience the most misconceptions on problem number 30 with indicators about analyzing surface tension correctly.

The results of the misconception of 46.81%, students assume that insects can walk on the surface of the water because the mass of the type of mosquito is smaller than the mass of the water type. The right answer is because of the surface tension. This is due to the presence of a force or pull down that causes the surface of the liquid to contract and the object in a tense state. Surface tension is the tendency of the fuide surface to stiffen so that its surface is covered by an elastic layer. The tense force is derived from the cohesion pull force (the force of attraction between similar molecules) (Hasanah, 2020). This misconception is due to incomplete reasoning. Reasoning is a type of analog reasoning that focuses on reasoning based on previous experience. Reasoning can also occur due to incorrect logic in drawing conclusions or generalizations, resulting in misconceptions (Kamid et al., 2020).

Capillary

Capillary subconception consists of 2 questions, of the 2 questions students experience the most misconceptions on problem number 31 with indicators about analyzing the mass of water that rises if the radius of capillary pipe is changed.

The findings obtained a misconception of 34.04%, when students were given the question to calculate the mass of water that rises in the capillary pipe if the water rises to the height of h_1 in the capillary pipe whose radius are r and the mass of water raised in the capillary pipe is M. where the radius is 2r. The majority of students responded by using the ratio $\frac{m_1}{r^2h} = \frac{m_2}{\frac{1}{4}r^2h}$ so that the mass of water rises in the capillary pipes. The correct answer is to use the ratio $\frac{m_1}{r^2h} = \frac{m_2}{4r^2h}$. so that the mass of water that rises in the capillary pipe so that the result of $4M$ is obtained. This is in accordance with the opinion of Rusilowati (2014) that students are better at memorization than science process skills.

Viscosity

The subconception of viscosity consists of 4 questions, of the 4 questions students experience the most misconceptions on problem number 34 with indicators about analyzing the relationship of viscosity values to temperature. The findings were 38.30% misconceptions. When students are given a table containing columns with viscosity values, they assume that viscosity varies with temperature. The correct

answer is that air has a high viscosity. This is because the higher the temperature, the smaller the viscosity value. Misconceptions occur because at the time of the interview Some students are not used to working on science literacy. In line with research Putri (2018) that students are not used to facing problems that are planning and load graphs or tables so that expertise is needed in observing the problem.

The percentage of overall misconceptions on the concept of hydrostatics falls into the high category. In general, students experience misconceptions in the field of physics caused by associative thinking on average contributed by 80.00%, humanistic thinking by 83.00%, incomplete reasons by 12.00%, wrong intuition by 86.00%, cognitive development stage by 85.00%, and student ability by 70.00%, while student learning interests did not contribute to student misconceptions (Fakhruddin et al., 2012). External factors experienced by students in the form of less available practicum and reference space. Handbooks or references that students refer to as material for learning only one and with the same source especially if the book used already contains misconceptions from the beginning, every student also does not have the initiative to find references, it causes the emergence of misconceptions (Irsanti et al., 2017).

The misconceptions revealed using the four-tier diagnostic test instrument can be a record for lecturers in carrying out learning, especially on the concept of hydrostatic. Knowing the location of student misconceptions will make it easier for lecturers to carry out improvements. With the presence of diagnostic tests of misconceptions like this, lecturers can immediately provide improvements to overcome these misconceptions. This is in accordance with the theory put forward by Nana Sukmadinata and Thomas about improvement activities that can be done with various different methods and treatments depending on the analysis of difficulties and learning development of students, among others: reimagining teaching, simplification of concepts, case studies, or applications to a higher level either by means of group discussion, assignment or project, or the use of other teaching media (Putri & Rinaningsih, 2013).

Conclusion

Based on expert validation from the four-tier diagnostic test assisted iSpring Suite 9, it can be concluded that the instruments that have been developed are suitable for use for research. The realibility of the question is calculated using the Alpha Cronbach coefficient and a realibility value of 0.93 is obtained. This shows that the questions used in the research are reliable. The results of the study, which identified student misconceptions regarding hydrotatics, can be concluded that there are still many students who experience misconceptions with a percentage of 70.21% at hydrostatic pressure, 40.43% on Pascal's legal concept, 42.55% on archimedes legal concept. 46.81% on the concept of surface tension and 34.04% on the concept of capillarity. Misconceptions in the field of physics mostly come from students themselves caused by several factors, among others: early student concepts, associative thinking, humanistic thinking, incomplete reasoning, wrong intuition, the stage of cognitive development of students, student abilities, and student learning interests. Based on the results that have been obtained from the four tier diagnostic tests, the misconceptions that occur are relatively high. Thus, lecturers need to immediately provide improvements to overcome these misconceptions.

Acknowledgements

We thank the Research and Community Service Institute (LPPM) of Universitas Islam Syekh-Yusuf who has supported in funding during our conduct of this research, so that it can be completed properly in accordance with the Rector's Decree OF UNIS Number: 52 of 2021. Thank you to material expert Januar Widakdo, S.Si, M.Sc., Ph.D and Siti Muryanah S.Kom., M.Kom as a media expert. Do not forget we thank all students of the Faculty of Engineering, Universitas Islam Syekh Yusuf who have helped a lot in succeeding this research activity.

References

Ariany, R. L., & Al-Ghifari, A. (2018). Penggunaan Software Anates Untuk Validasi Instrumen Tes. *Al-Khidmat*, *1*(1). https://doi.org/10.15575/jak.v1i1.3327

Arikunto, S. (2013). *Prosedur Penelitian Suatu Pendekatan Praktik*. Rineka Cipta.

Ariyanto, M. H. (2021). *Analisa Pengaruh Tekanan Pada Kemiringan Dan Diameter Pipa Masuk Terhadap Pipa Keluar Pada Sistem Pengangkatan Air*. http://repository.untag-sby.ac.id/id/eprint/10309

Arslan, H. O., Cigdemoglu, C., & Moseley, C. (2012). A Three-Tier Diagnostic Test to Assess Pre-Service Teachers' Misconceptions about Global Warming, Greenhouse Effect, Ozone Layer Depletion, and Acid Rain. *International Journal of Science Education*, *34*(11). https://doi.org/10.1080/09500693.2012.680618

Butler, J., Mooney Simmie, G., & O'Grady, A. (2015). An investigation into the prevalence of ecological misconceptions in upper secondary students and implications for pre-service teacher education.

European Journal of Teacher Education, *38*(3), 300–319. https://doi.org/10.1080/02619768.2014.943394

Caleon, I. S., & Subramaniam, R. (2010). Do students know What they know and what they don't know? Using a four-tier diagnostic test to assess the nature of students' alternative conceptions. *Research in Science Education*, *40*(3). https://doi.org/10.1007/s11165-009-9122-4

Çelikten, O., İpekçioğlu, S., Ertepınar, H., & Geban, Ö. (2012). The effect of the conceptual change-oriented instruction through cooperative learning on 4th grade students' understanding of earth and sky concepts. *Science Education International*, *23*(1), 84–96. https://eric.ed.gov/?id=EJ975551

Chen, Y., Irving, P. W., & Sayre, E. C. (2013). Epistemic game for answer making in learning about hydrostatics. *Physical Review Special Topics - Physics Education Research*, *9*(1). https://doi.org/10.1103/PhysRevSTPER.9.010108

Cooper, M. M., & Klymkowsky, M. W. (2013). The trouble with chemical energy: Why understanding bond energies requires an interdisciplinary systems approach. *CBE Life Sciences Education*, *12*(2), 306–312. https://doi.org/10.1187/cbe.12-10-0170

Dasmo, Lestari, A. P., & Alamsyah, M. (2020). Peningkatan Hasil Belajar Fisika Melalui Penerapan Media Pembelajaran Interaktif Berbasis Ispring Suite 9. *Prosiding Seminar Nasional Sains*, *1*(1). http://proceeding.unindra.ac.id/index.php/sinasis/article/view/3979

Djanette, B., & Fouad, C. (2014). Determination of University Students' Misconceptions about Light Using Concept Maps. *Procedia - Social and Behavioral Sciences*, *152*. https://doi.org/10.1016/j.sbspro.2014.09.247

Fakhruddin, Azizahwati, & Rahmi, Y. (2012). Analisis Penyebab Miskonsepsi Siswa pada Pelajaran Fisika di Kelas XII SMA/MA Kota Duri. *Jurnal Pendidikan Matematika*, *3*(1), 87–98. https://doi.org/10.36709/jpm.v3i1.1988

Fariyani, Q., Rusilowati, A., & Sugianto. (2015). Pengembangan Four-Tier Diagnostic Test Untuk Mengungkap Miskonsepsi Fisika Siswa SMA Kelas X. *JISE*, *4*(2). http://journal.unnes.ac.id/sju/index.php/jise

Gurel, D. K., Eryilmaz, A., & McDermott, L. C. (2015). A review and comparison of diagnostic instruments to identify students' misconceptions in science. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(5). https://doi.org/10.12973/eurasia.2015.1369a

Hasanah, D. S. (2020). Pengaruh Model Pembelajaran Inquiry Based Learning Terhadap Self Efficacy Dan Literasi Sains Siswa SMA. *Asean Journal of Science Education*. 3(2). https://doi.org/10.24815/ajse.v3i2.20308

Hidayati, T., Nugroho, E.S., & Sudarmin. (2013). Pengembangan Tes Diagnostik Untuk Mengidentifikasi Keterampilan Proses Sains Dengan Tema Energi Pada Pembelajaran IPA Terpadu. *Unnes Science Education Journal*, *2*(2). https://journal.unnes.ac.id/sju/index.php/usej/article/view/2041

Hikmawati, & Sutrio. (2019). *Miskonsepsi dalam Fisika*. Garuda Ilmu.

Imansari, M., Sudarmin, S., & Sumarni, W. (2018). Analisis Literasi Kimia Peserta Didik Melalui Pembelajaran Inkuiri Terbimbing Bermuatan Etnosains. *Jurnal Inovasi Pendidikan Kimia*, *12*(2). https://doi.org/https://doi.org/10.15294/jipk.v12i2.15480

Irsanti, R., Khaldun, I., & Hanum, L. (2017). Identifikasi Miskonsepsi Siswa Menggunakan Four-TierDiagnostic Test pada Materi Larutan Elektrolit dan Larutan Non Elektrolit di Kelas X SMA Islam Al-falah Kabupaten Aceh Besar. *Jurnal Ilmiah Mahasiswa Pendidikan Kimia (JIMPK)*, *2*(3), 230–237. http://jim.unsyiah.ac.id/pendidikan-kimia/article/view/4927/2084

Kaltakci-Gurel, D., Eryilmaz, A., & McDermott, L. C. (2017). Development and application of a four-tier test to assess pre-service physics teachers' misconceptions about geometrical optics. *Research in Science and Technological Education*, *35*(2). https://doi.org/10.1080/02635143.2017.1310094

Kamid, Anwar, K., Syaiful, Sofnidar, Liani, L., & Kurniawan, W. (2020). Investigation into first-year college students' misconceptions about limit concept: A case study based on cognitive style. *Universal Journal of Educational Research*, *8*(4). https://doi.org/10.13189/ujer.2020.080437

Mutlu, A., & Sesen, B. A. (2015). Development of a Two-tier Diagnostic Test to Assess Undergraduates' Understanding of Some Chemistry Concepts. *Procedia - Social and Behavioral Sciences*, *174*, 629–635. https://doi.org/10.1016/j.sbspro.2015.01.593

Ninawati, M., Burhendi, F. C. A., & Wulandari. (2021). Pengembangan E-Modul Berbasis Software iSpring Suite 9. *Jurnal Educatio*, *7*(1). https://ejournal.unma.ac.id/index.php/educatio/article/view/830/547

Purnama Sari, M., & Ridwan, R. (2020). Pengembangan Multimedia Interaktif Menggunakan Aplikasi Ispring Suite 9 Pada Pembelajaran IPA Kelas IX Di SMP Negeri 5 Panyabungan. *Jurnal Penelitian IPTEKS*, *5*(2). https://doi.org/10.32528/ipteks.v5i2.3660

Putri, K. P., & Rinaningsih. (2013). Pengembangan Tes Diagnostik Materi Teori Mekanika Kuantum Dan Ikatan Kimia (The Development Of Diagnostic Test Chapter Quantum Mechanics Theory And Chemical Bonding). *Unesa Journal of Chemical*

Education, *2*(2), 159–172. https://jurnalmahasiswa.unesa.ac.id/index.php/journal-of-chemical-education/article/view/2759/1650

Putri, M. E. (2018). *Analisis Kemampuan Literasi Sains Biologi Siswa SLTP Se-Kecamatan Pantai Cermin Kabupaten Solok*.

Rusilowati, A. (2014). Analisis Buku Ajar IPA yang Digunakan Di Semarang Berdasarkan Muatan Literasi Sains. *Seminar Nasional Konservasi Dan Kualitas Pendidikan 2014*.

Rusilowati, A. (2015). Pengembangan Tes Diagnostik Sebagai Alat Evaluasi Kesulitan Belajar Fisika. Prosiding: *Seminar Nasional Fisika dan Pendidikan Fisika*. Retrieved from https://jurnal.fkip.uns.ac.id/index.php/prosfis1/article/view/7684

Sarlina. (2015). Miskonsepsi Siswa Terhadap Pemahaman Konsep Matematika Pada Pokok Bahasan Persamaan Kuadrat Siswa Kelas X5 SMA Negeri 11 Makassar. *Mapan: Jurnal Matematikan dan Pembelajaran*. *3*(2), 2581–172. https://doi.org/10.24252/mapan.2015v3n2a5

Septiyani, E., & Nanto, D. (2021). Four-Tier Diagnostic Test Assisted Website for Identifies Misconceptions Heat and Temperature. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *7*(1). https://doi.org/10.21009/1.07104

Soeharto, S., & Csapó, B. (2021). Evaluating item difficulty patterns for assessing student misconceptions in science across physics, chemistry, and biology concepts. *Heliyon*, *7*(11). https://doi.org/10.1016/j.heliyon.2021.e08352

Sulistiawarni, W. (2018). *Identifikasi Miskonsepsi Menggunakan Four-Tier Diagnostic Test Materi Suhu dan Kalor Siswa SMA/MA*. https://eprints.walisongo.ac.id/id/eprint/9343/1/1403066019.pdf

Suwarna, I. (2013). *Analisis Miskonsepsi Siswa SMA Kelas X Pada Mata Pelajaran Fisika Melalui CRI (Certainty Of Response Index) Termodifikasi*. https://repository.uinjkt.ac.id/dspace/bitstream/123456789/24028/3/...pdf

Taslidere, E. (2016). Development and use of a three-tier diagnostic test to assess high school students' misconceptions about the photoelectric effect. *Research in Science and Technological Education*, *34*(2), 164–186. https://doi.org/10.1080/02635143.2015.1124409

Zulfa, S. I., Nikmah, A., & Khoirun, E. (2017). Analisis Penguasaan Konsep pada Tekanan Hidrostatis dan Hukum Pascal Mahasiswa Pendidikan Fisika. *Jurnal Fisika Indonesia*. 24(1). https://doi.org/10.22146/jfi.v24i1.51870