Available online at: http://journal.uny.ac.id/index.php/jipi

Jurnal Inovasi Pendidikan IPA, 9 (1), 2023, 95-106

Investigating concept mastery of physics students during online lectures through Rasch models on force and motion materials

Fauzan Sulman[1,2]*, Lia Yuliatai[2], Sentot Kusairi[2], Arif Hidayat[2], Jupet Pentang[3], Bismark Mensah[4]
[1] Thaha Saifuddin State Islamic University Jambi. Jambi, Indonesia
[2] State University of Malang. Malang, Indonesia
[3] Western Philippines University, Puerto Princesa City, Philippines
[4] Univesity of Education, Winneba, Ghana
* Corresponding Author. E-mail: fauzansulman@uinjambi.ac.id

Received: 8 January 2023; Revised: 15 March 2023; Accepted: 17 March 2023

Abstract: Mastery of concepts and solving is the most crucial part of Physics Lectures. The concept of understanding describes students' understanding of the actual physics material. This research aims to analyze students' mastery of physics concepts in the material of Force and Motion while lectures are conducted online. This study uses a mixed-method approach to explain students' answers that still need clarification. Data analysis was carried out using the Rasch model, and a questionnaire was developed based on the possibility of students' responses to the concepts of force and motion. The results of this study indicate that students' understanding of the concept of force and motion material still needs to improve, namely 64.062%, around 94% of glasses Tadris students think that the force and motion material given by lecturers during exams is challenging. More than 60.94% of students believe this is because the ability of the force and motion material they have still needs to improve. These results are interpreted based on analysis through the Winstep application Version 3.65.0. Moreover, qualitative data were obtained from interviews. It takes a learning model that is appropriate for use in online and offline learning.

Keywords: *Conceptual understanding, Rasch Models, Online Learning*

How to Cite: Sulman, F., Yuliatai, L., Kusairi, S., Hidayat, A., Pentang, J. & Mensah, B. (2023). Investigating concept mastery of physics students during online lectures through Rasch models on force and motion materials. *Jurnal Inovasi Pendidikan IPA, 9*(1), 95-106. doi:http://dx.doi.org/10.21831/jipi.v8i1.57308

INTRODUCTION

In the era of the Industrial Revolution 4.0, the process of education and science is always supported by technology and is an inherent and inseparable unit in the lecture process (Hariharasudan & Kot, 2018; Shatalebi et al., 2011). Higher education is the most important forum for realizing a new paradigm in the education system, especially in physics education (Ouyang & Jiao, 2021; Sulman, 2019; Sulman et al., 2020). Higher education is the most critical forum for realizing a new paradigm in the education system, especially physics education (Sulman, Sutopo, et al., 2021). In the context of the use of technology in the lecture process, the analysis of conceptual understanding and cheating in answering questions in physics learning is critical so that both conceptual abilities and educators' misconceptions about the actual quality of students during lectures, both face to face and distance can be observed (Sulman, 2012; Sulman, Sutopo, et al., 2021; Sulman, Yuliati, Kusairi, et al., 2022; Veugen et al., 2021).

The success of students in the lecture process can be seen in how much students understand the concepts of the material being studied (Goodhew et al., 2021; Meltzer, 2002) and how much they can do the test questions given (Gurcay & Gulbas, 2015; Putra et al., 2021; Rozal et al., 2021; Sulman, Tanti, et al., 2021; Zb et al., 2020; Zb, Setiawan, et al., 2021) because both are a unity that cannot be separated in an assessment conclusion, in other words, students have difficulty in analyzing contextual problems in a theory or modeling (Kibirige & Mamashela, 2022; Nehru et al., 2020).

Lectures should be a form of learning that can connect two learning environments simultaneously (Aycock et al., 2002; Hapke et al., 2020), one of which combines face-to-face and distance learning which has been proven to increase student creativity (Rosbottom, 2001; Zb, Setiawan, et al., 2021), and

http://dx.doi.org/10.21831/jipi.v8i1.57308

is a solution and necessity in this era, so that the learning process can be carried out both in normal and emergency conditions such as the Covid-19 pandemic (Sulman, Yuliati, Purnama, et al., 2022; Zb, Setiawan, et al., 2021). Lectures must maintain the quality and student learning outcomes to the maximum, which can be used in solving problems in various conditions (Kibirige & Mamashela, 2022; Lestari et al., 2021). Students coming to campus or not will be able to receive learning with the same quality because the learning objectives are designed to provide knowledge, or it is cross-border learning (Cremers et al., 2014). All students' knowledge and beliefs can be maximized by using appropriate learning models so that students' conceptual mastery abilities are expected to be maximally maintained. Students' ability can be proven to answer questions well in offline and online test questions. Answering a question correctly must be accompanied by good mastery to solve the given problem. The maximum ability possessed by students can be realized if all concepts can be used in solving problems, and physics lectures, both online and offline, must be able to encourage and motivate students in the learning process. If using a suitable learning model, it is believed to be able to make the physics learning process fun. In various conditions (Zb, Novalian, et al., 2021), this is one of the essential things in a physics lesson, so mastery of concepts can be built quickly and maximally.

Mastery concepts are essential so students can apply them in problem-solving (Nisa' et al., 2019). Almost all studies have tried to reveal students' understanding of concepts under normal conditions (Helms, 2014; Lin, 2008; Rosbottom, 2001), and very few studies on learning models that can be solutions and used amid a pandemic (Zb, Setiawan, et al., 2021). Mastering student concepts with a suitable learning model is believed to be able to contribute to the maximum while at the same time being able to show a student's true abilities in solving problems so that both inhibiting factors in the process of understanding material concepts and indications of cheating in various conditions can be minimized, one of which is in introductory physics courses, especially in force and motion.

The concepts of force and motion have an important role in learning physics. Student's difficulties in understanding force and motion have a long history in physics education research and science education (Bayraktar, 2009; Brookes & Etkina, 2009; Tao et al., 2018; Thornton & Sokoloff, 1998). Students in mastering style and motion experience various kinds of difficulties. Difficulty mastering the material in studying force and motion, including determining the components of the total force (Singh & Schunn, 2009), 3) determining the magnitude and direction of acceleration of moving objects (Sutopo et al., 2012). In addition, students also often misunderstand the relationship between acceleration and force. Most students think that the relationship between acceleration and force is not a covariance relationship but a causal relationship (Sutopo et al., 2012) and also that students may not all be able to activate a model where "moving force" is needed to maintain a constant speed of motion under certain conditions (Brookes & Etkina, 2009). The difficulties experienced by students have an impact on low-concept understanding. Moreover, learning is carried out outside of ideal conditions; the difficulties of students in Style and Motion material are certainly more severe with conditions or circumstances that are out of the ordinary and must be addressed given a solution so that students are still able to master concepts well and can use them to solve problems. Student's difficulties in mastering force and motion still need to be investigated further (Meiliani et al., 2021).

The problems above show that understanding the concepts of force and motion is a fascinating study to observe and analyze further because it is a fundamental requirement for a spectacles educator and is the foundation for students to understand physics material further. Therefore in kinematics material, especially force and motion, where the relationship between concepts is significant and if students can link between concepts in solving a problem and students show in detail and are good at interpreting all components that theoretically work, then learning can run optimally (Mufida & Widodo, 2021; Reyza et al., 2023). The expected understanding of the concept in the lecture process is where students can understand not only physical concepts but also be able to apply them to solving a problem so that the physics theory obtained by students is not only a formula for training or working on questions but more profound than the concept. The concept of glasses can be used to be applied in life. Of course, in the middle of both online and offline lectures, accuracy is needed in choosing a lecture strategy (Mutanaffisah et al., 2021) so that students are indeed able to have an understanding of concepts that are students' fundamental abilities towards the physics material being studied. Therefore, the study of mastery of student concepts in the application of learning needs to be carried out in a more in-depth analysis, especially in conditioning lectures during the pandemic and the new normal.

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

METHOD

Mixed-method in the form of an explanatory Sequential Design model Design (Creswell, 2012) s a form of research used in this study. The picture of the research design in the study can be seen in Figure 1.

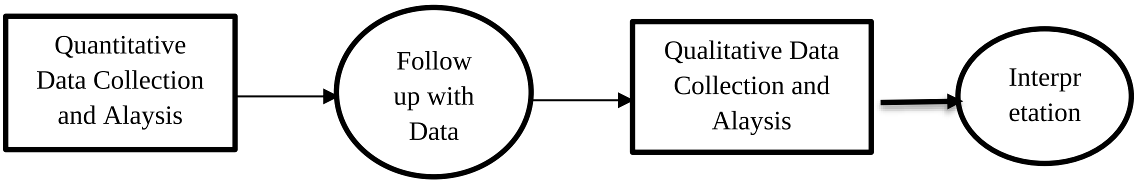


Figure 1. Explanation Design: Follow-up Explanation Model (Quan Emphasized) (Creswell, 2012)

The research was conducted at the State Islamic University of Sultan Thaha Saifuddin Jambi, Indonesia, with the focus and research subject on Physics education undergraduate program students. In this study, the population used was 65 students who had taken or studied basic physics. The research sample comprised 65 students (9 male and 56 female). The research subjects are in semesters II, IV, and VI, aged 18 to 23 years. The sampling process uses a total sampling technique (Creswell, 2012). The sampling technique in research aims so that the data taken can represent the description of the research results and by the Rasch model process where the more population that represents the research subject, the better the data will be (Sulman, Sutopo, et al., 2021). Data Interviews were conducted with all respondents, amounting to 65 people, so the answers truly represented the respondents.

This research uses two types of data: quantitative and qualitative. For quantitative data in this study, a test is used as a student's concept understanding test in multiple-choice questions, totaling 47 questions from Force Conceptual Understanding. FMCE is a standard instrument commonly used to assess students' conceptual understanding of force and motion (Kohl & Finkelstein, 2008; Meltzer, 2002; Stewart et al., 2021; Sulman, Sutopo, et al., 2021). Expert experts have validated the item items used in the research to become a reference before the research. According to the results of expert validation, several notes and concerns were obtained before the questions were used. After improvements were made according to expert advice, the questions were usable or valid. After that, empirical validity was carried out in a modern way, where the research instrument used a model program with the Winstep program Version 3.65.0 so that the instrument was able to measure students' mastery of concepts in force and motion material. The research process Then continued with the interview process in the form of 2 questions, namely initial and follow-up questions. Students are asked to describe the problem-solving process used in answering questions. The data obtained from the results of interviews that have been conducted are used to become reinforcement and a tool to detect indicators of students' absolute concept mastery, primarily when online tests are carried out so that they can see more deeply from the student's point of view as respondents how students in learning carry out the process. Answer the forces and materials of motion.

Data analysis in this study is to combine approaches, namely quantitative and qualitative. Quantitative data analysis used the Rasch model point of view, and qualitative data was taken using interview questionnaires which were also used to strengthen the results of quantitative data analysis on student concept mastery tests on force and motion material. The test results obtained are analyzed after all respondents have completed online lectures. Through the Rasch model with the Winstep application Version 3.65.0. it will be apparent that the mastery of the students' concepts after online learning is carried out. The research data analyzed through the Winsteps Version 3.65.0 program will get item parameters that fit based on the Rasch model. The reliability of the questions used is determined based on the magnitude of the value between the reliability of each item and the reliability of the item as a whole, with a considerable Cronbach alpha value as a reference. Then, the item model is considered appropriate if the MNSQ Outfit value is 0.5 to 1.5.

The standard Z value (ZSTD) ranges from -2.0 to 2.0. Then the correlation value ranges from 0.4 to 0.85. This indicator becomes a reference in seeing questions that are fit or already by the Rash model. Mastery of concepts was analyzed using the Rasch model through the Wright Map and the DIF Item graph based on the logit scale. For mastery of student concepts, it will be reviewed from the logit Mesure scale value, where the logit average value is always set at 0.0 logit, which is the standard for the level

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

of difficulty of the questions and the standard of student ability (Bohori & Liliawati, 2019; Sulman, Sutopo, et al., 2021). If the student's ability is spread below 0.0 logit, the student's mastery of concepts is weak, and vice versa. Then for qualitative data, the results of student questionnaires for the first question will be presented as a percentage of the difficulty of the questions being worked on, whether complex, medium, or easy. Then proceed with follow-up interviews to get more detailed and in-depth results regarding the obstacles experienced by students in money lectures conducted online.

The steps of data analysis are; (1) The online test questions are collected in big data in Excel format, and (2) the coding process is carried out. (3) Then, the test results were tested using the Winstep program Version 3.65.0 and presented to map each student's conceptual understanding regarding force and motion in answering test questions. (4) The first question questionnaire is distributed. (5) The coding process is carried out. (6) Presentation of Analysis Results. (7). Follow-up question questionnaire (8) Coding process (9) Presentation of analysis results (10) Concluding analysis results from quantitative and qualitative data (11) Providing Conclusion Interpretation on special force and motion material in online lectures.

RESULT AND DISCUSSION

Analysis of Student Concept Mastery

From the research process that has been carried out, it is very clear and detailed that the actual ability of students is detected to have a significant difference, one of which is from understanding the concept (Maya et al., 2023; Riantoni & Yelianti, 2023; Sofna et al., 2023). an understanding of the concepts that individuals should have to be able to solve all physics problems comprehensively and better, which of course, can be proven directly in the application of the concepts given both in problem-solving and application in everyday life (Reyza et al., 2023; Taqwa et al., 2022). Understanding the concept from the results of observations made, especially in the eyes of material force and motion, is a must that students must possess. The results of student observations showed that they were not good enough or able to master the concepts of force and motion, so they would have difficulty understanding further understanding at a higher level (Yusuf et al., 2022; Zakwandi et al., 2022). The importance of detecting student understanding of concepts makes students skilled and able to participate in the learning process fully.

In the research that has been carried out, some important data can be used as input where the importance of understanding the concept must be seen and investigated so that it can become input for the world of physics education in the future, such as the data obtained in this study. The data on student learning outcomes can be seen from personal statistics: measure order. The distribution of student scores can be seen in Figure 2.

From Figure 2. If it is seen from the Outfit Mean Squared (Outfit MNSQ) value in Figure 2, the score is 1.00, and the person's score is 0.7. The research data presented shows the accuracy of the instrument to be used. The measurement criteria clearly explained in the appropriate item category are $0.5 < MNSQ < 1.5$, so the force and motion instruments are valid for measuring students' mastery of concepts. Then it can also be stated that the data obtained has a value that is most likely very rational. The acceptance of a good assessment of the mastery of the concept of force and motion as a measuring tool is because the Outfit Z Standardized (ZSTD) score is 0.38 for people and 0.1 for items. In other words, overall, the questions used have met the criteria of the Rasch model (Shea et al., 2012; Sulman, Sutopo, et al., 2021; Tseng et al., 2019), and in terms of the average score, the respondent must answer this question because the question is straightforward, namely at an average score of -1.87. The criteria that have been presented show that the instrument used is feasible to test students' mastery of concepts.

The results of the data analysis of student's mastery of concepts on the force and motion material that can be seen in Figure 2 can be described as that of 64 students. Only one person can answer correctly 27 questions, namely the student with code 4A22, who, if converted with a score of 100, will get a 60. Two students can answer correctly 14 to 16 questions (scores 31.35 to 35.55). Then 20 students could only correctly answer nine to 13 questions (scoring 20 to 28.89). Thirty students can answer five to 8 questions (scores 11.11 to 17.78). A total of 12 students could only answer 2 to 4 questions (scoring 4.44-8.87), and students obtained the lowest score with code 6A16. The data presented above clearly shows the low concept ability of students during online learning. The low ability of students is a clear

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

indication that there is a need to improve online learning patterns (Dong et al., 2020; Mishra et al., 2020; Shah et al., 2021), which are genuinely appropriate for achieving lecture goals.

PERSON STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	PERSON
23	27	47	.33	.31	1.03	.4	1.07	.6	.28	59.6	64.2	4A22
17	16	47	-.75	.32	1.07	.6	1.04	.3	.23	68.1	69.5	4A16
26	14	47	-.97	.34	1.15	1.1	1.11	.5	.13	61.7	72.3	8A1
14	13	47	-1.08	.34	.99	.0	.98	.0	.30	74.5	73.8	4A13
4	12	47	-1.20	.35	.94	-.3	.86	-.5	.38	76.6	75.4	4A4
47	12	47	-1.20	.35	1.10	.6	1.16	.7	.15	72.3	75.4	6A18
1	11	47	-1.33	.36	1.08	.5	1.26	1.0	.13	78.7	77.2	4A1
39	11	47	-1.33	.36	1.11	.7	1.14	.6	.14	70.2	77.2	6A11
62	11	47	-1.33	.36	1.11	.6	1.10	.4	.15	74.5	77.2	6A30
63	10	46	-1.43	.37	1.07	.4	1.36	1.2	.15	71.7	78.5	4A31
5	10	47	-1.46	.37	1.03	.2	1.05	.3	.23	78.7	78.9	4A5
7	10	47	-1.46	.37	1.04	.3	.99	.1	.23	78.7	78.9	4A7
29	10	47	-1.46	.37	1.03	.2	1.08	.4	.22	78.7	78.9	6A2
37	10	47	-1.46	.37	.96	-.1	.81	-.6	.35	78.7	78.9	6A9
56	10	47	-1.46	.37	.93	-.3	.88	-.3	.36	83.0	78.9	6A25
35	9	46	-1.54	.39	1.07	.4	1.06	.3	.16	78.3	80.5	6A7
9	9	47	-1.61	.39	.75	-1.1	.62	-1.2	.57	80.9	80.8	4A9
13	9	47	-1.61	.39	.96	-.1	.83	-.4	.34	80.9	80.8	4A12
19	9	47	-1.61	.39	.94	-.2	.87	-.3	.34	80.9	80.8	4A18
31	9	47	-1.61	.39	1.07	.4	1.13	.5	.17	80.9	80.8	4A25
33	9	47	-1.61	.39	.78	-1.0	.62	-1.2	.55	80.9	80.8	6A5
44	9	47	-1.61	.39	.91	-.3	.78	-.6	.40	80.9	80.8	6A15
48	9	47	-1.61	.39	1.00	.1	.88	-.2	.29	80.9	80.8	6A19
2	8	47	-1.76	.40	.96	-.1	.88	-.2	.31	83.0	83.0	4A2
8	8	47	-1.76	.40	.99	.0	.89	-.2	.28	83.0	83.0	4A8
10	8	47	-1.76	.40	1.02	.1	1.02	.2	.22	83.0	83.0	4A10
18	8	47	-1.76	.40	.85	-.5	.72	-.7	.44	83.0	83.0	4A17
25	8	47	-1.76	.40	1.06	.3	1.07	.3	.17	83.0	83.0	4A24
28	8	47	-1.76	.40	1.12	.5	1.17	.6	.11	83.0	83.0	2A2
32	8	47	-1.76	.40	.96	-.1	.84	-.3	.32	83.0	83.0	6A4
41	8	47	-1.76	.40	1.07	.4	1.46	1.2	.13	83.0	83.0	6A12
50	8	47	-1.76	.40	1.01	.1	.84	-.3	.28	83.0	83.0	4A27
52	8	47	-1.76	.40	.87	-.5	.66	-.9	.45	83.0	83.0	4A28
53	8	47	-1.76	.40	.98	.0	.92	-.1	.28	83.0	83.0	6A22
54	8	47	-1.76	.40	1.06	.3	1.00	.1	.19	83.0	83.0	6A23
59	8	47	-1.76	.40	.93	-.2	.82	-.4	.35	83.0	83.0	6A28
60	8	47	-1.76	.40	.82	-.7	.69	-.8	.48	83.0	83.0	6A29
3	7	47	-1.93	.42	1.23	.9	3.23	3.6	-.25	85.1	85.1	4A3
11	7	47	-1.93	.42	.89	-.3	.72	-.6	.40	85.1	85.1	2A1
15	7	47	-1.93	.42	.92	-.2	.97	.1	.30	85.1	85.1	4A14
49	7	47	-1.93	.42	1.05	.3	.98	.1	.19	85.1	85.1	6A20
57	7	47	-1.93	.42	1.10	.4	1.19	.6	.10	85.1	85.1	6A26
58	7	47	-1.93	.42	1.06	.3	1.18	.5	.14	85.1	85.1	6A27
61	7	47	-1.93	.42	1.11	.5	1.00	.1	.14	85.1	85.1	4A29
30	6	47	-2.13	.45	1.06	.3	1.24	.6	.12	87.2	87.2	6A3
36	6	47	-2.13	.45	1.06	.3	.97	.1	.18	87.2	87.2	6A8
55	6	47	-2.13	.45	1.11	.5	1.18	.5	.08	87.2	87.2	6A24
12	5	47	-2.35	.49	.95	.0	.84	-.1	.29	89.4	89.4	4A11
20	5	47	-2.35	.49	.99	.1	.96	.1	.22	89.4	89.4	4A19
21	5	47	-2.35	.49	1.10	.4	1.79	1.4	-.02	89.4	89.4	4A20
38	5	47	-2.35	.49	1.00	.1	.77	-.3	.26	89.4	89.4	6A10
43	5	47	-2.35	.49	.99	.1	.94	.1	.22	89.4	89.4	6A14
46	5	47	-2.35	.49	.82	-.4	.52	-.9	.48	89.4	89.4	6A17
6	4	47	-2.61	.54	.84	-.3	.48	-.8	.45	91.5	91.5	4A6
16	4	47	-2.61	.54	.89	-.1	.51	-.8	.40	91.5	91.5	4A15
22	4	47	-2.61	.54	1.01	.2	.91	.1	.20	91.5	91.5	4A21
24	4	47	-2.61	.54	.96	.0	.65	-.4	.30	91.5	91.5	4A23
40	4	47	-2.61	.54	1.08	.3	1.71	1.2	.03	91.5	91.5	4A26
42	4	47	-2.61	.54	.79	-.4	.39	-1.1	.51	91.5	91.5	6A13
64	4	47	-2.61	.54	1.05	.3	1.14	.4	.11	91.5	91.5	4A32
27	3	47	-2.93	.61	1.00	.2	1.18	.5	.15	93.6	93.6	6A1
34	3	47	-2.93	.61	1.10	.4	1.26	.6	.02	93.6	93.6	6A6
51	3	47	-2.93	.61	.97	.1	.74	-.1	.24	93.6	93.6	6A21
45	2	47	-3.38	.73	.95	.1	.63	-.2	.25	95.7	95.8	6A16
MEAN	7.9	47.0	-1.87	.43	1.00	.1	1.00	.1		83.2	83.7	
S.D.	3.7	.2	.59	.08	.10	.4	.38	.7		7.2	6.1	

Figure 2. Distribution of student answers based on the Rash Model

The results of the analysis of questions answered by students can be seen on the Wright Item-Student Map in Figure 3.

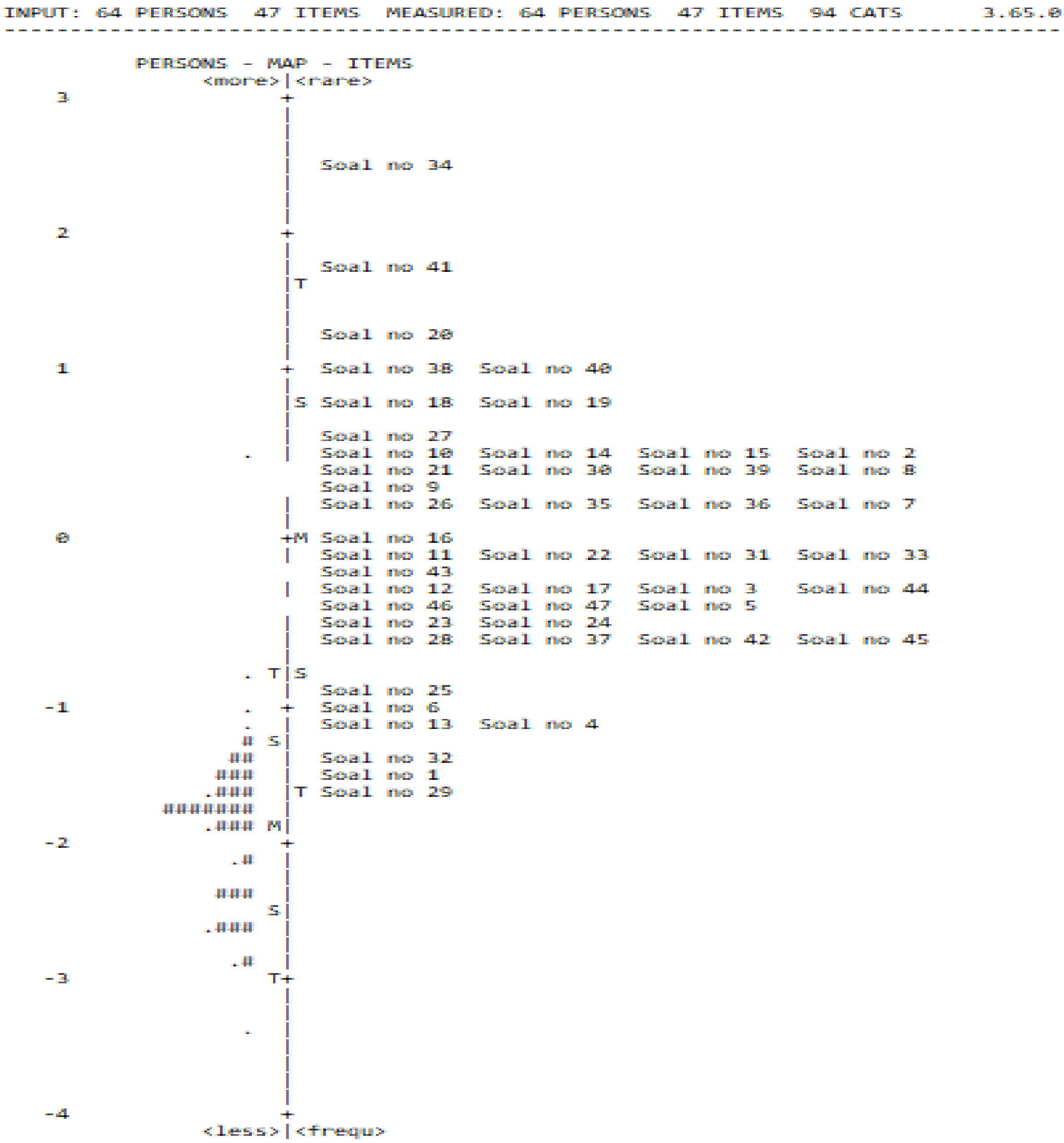


Figure 3. Wright map of questions

Figure 2 shows that the questions are actually in a proper category as a measuring tool for mastery of concepts in both online and offline lectures. The questions shown in the picture on the right above are the difficulty level of the questions that the respondent must answer. The problem analysis is viewed from the logit value of 0.0, which is the standard for measuring the ability and difficulty of the questions. Questions 34, 41, 20, 38, and 40 are the most difficult questions with a logit value greater than one logit, while questions 25, 6, 13, 4, 32, 1, and 29 are questions with low criteria with low-value criteria Logit 1, which should be very easy for the respondent to answer. Then the remaining 34 questions are within the criteria that students should be able to answer if they have a good mastery of concepts. Judging from the questions answered by students, it can be concluded that mastery of student concepts is still low. On average, students have not been able to answer questions optimally. For more details on the mastery of student concepts on the material of force and motion, it can be seen in Figure 4.

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

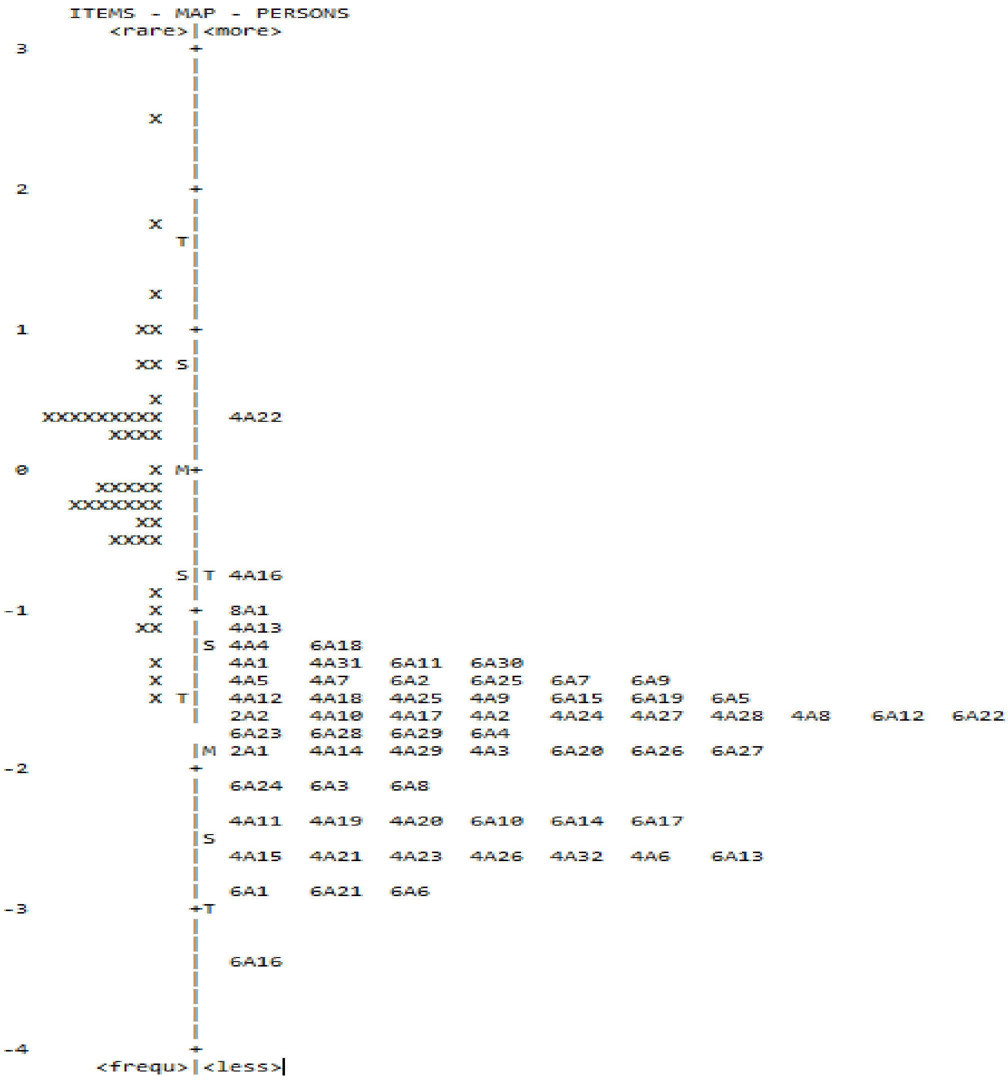


Figure 4. Wright person-item Peta map

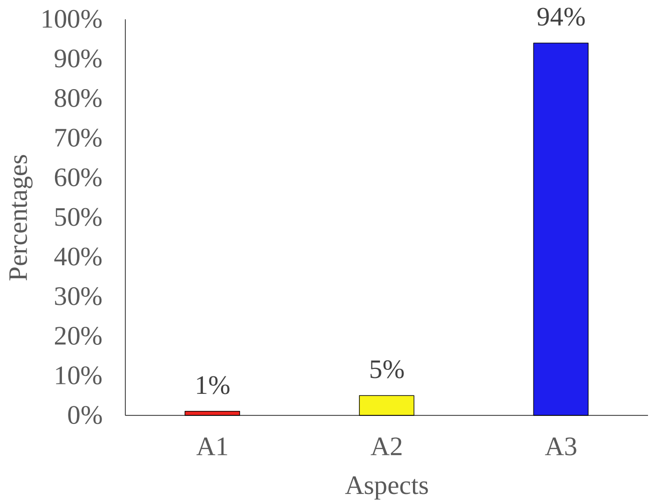
Based on the data obtained through the Wright map in Figure 3, it can be observed how the distribution of students' abilities in answering each concept mastery question is. Figure 3 shows that about five questions are rated logit 1, which students can answer. Students with code 4A22 have the highest concept mastery skills and can answer questions with medium, low averages and several questions in the high category with logit scores. The data in Figure 3 clearly shows that mastery of concepts will enable students to answer questions in all categories and not only in some categories (Mestre et al., 2011; Stoen et al., 2020; Wells et al., 2019). The research data obtained and presented in Figure 3 indicates that students with code 4A22, as shown by the Rasch model, have a good mastery of concepts. Students below 0.0 logit are included in the category with below-average concept mastery skills in the standard difficulty level. The division of Figure 3 can be simplified in Table 1

Table. 1 Student Concept Mastery on Force and Motion Materials

Item	Student Code	N	%	Category
1	4A22	1	1,563%	Excellent
2	4A16, 8A1, 4A13, 4A4, 6A18, 4A1, 4A31, 6A11, 6A30, 4A5, 4A7, 6A2, 6A25, 6A7, 6A9, 4A12, 4A18, 4A25, 4A9, 6A15, 6A19, 6A5	22	34,375%	Low
3	2A2, 4A10, 4A17, 4A2, 4A24, 4A27, 4A28, 4A8, 6A12, 6A22, 6A23, 6A28, 6A29, 6A4, 2A1, 4A14, 4A29, 4A3, 6A20, 6A26, 6A27, 6A25, 6A3, 6A8, 4A11, 4A19, 4A20, 6A10, 6A14, 6A17 4A15, 4A21, 4A23, 4A26, 4A32, 4A6, 6A13, 6A1, 6A21, 6A6, 6A16	41	64,062%	Very Low

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

Table 1 shows that, on average, only one student mastered the concept of force and motion in the excellent category. Then 22 people have a common concept understanding. In addition, there are as many as 41 students in the outliers category (under the T scale of questions), or students who have low abilities from the lowest difficulty of questions or, in other words, have meager conceptual understanding abilities. Thus, lecturers should make this an early warning in online lectures that are being carried out, especially for 41 students. The analysis continued with the interview process, where the results of the data obtained can be seen in Figure 5



A1: The question given are easy; A2 : The question given are mediun; A3 : The question given are difficult

Figure 4. The results of the interview test students' difficulties in the problem of mastery of the concept of force and motion

Figure 4 it can be seen how the student's responses after the test; There are three primary forms of all respondents' answers, where only 1% (1 person) of respondents stated that the questions analyzed were easy, then 5% (3 people) of respondents stated that the force and motion test questions had moderate difficulty, and 94% (61 people) respondents said the test questions were difficult. Qualitative test data from interviews align with the results of quantitative tests that students have carried out on mastery of concepts where most students experience difficulties or fail to give correct answers. Then proceed with a different interview process to find out the obstacles students experience during the lecture process using online lectures in answering. Interview questions were carried out after students found out the results of the tests given, then students were taken to be interviewed. Interview questions were only used in 3 forms questions whether the tests and material were easy, medium, or complicated, then the researchers made them into quantitative values so that they were easy to see and understand.

From Figure 5, which is regarding the follow-up analysis of the interview, the difficulties faced by students in answering the question of force and motion are divided into three components, namely the lack of understanding of the material, the distribution of lecture time that is not maximal and learning resources that are still lacking. As for the results of interviews with students, data was obtained that as many as 39 students (60,94%) thought difficulties occurred because of a lack of understanding of the material. As many as 16 people (25%) thought the inappropriate distribution of lecture time resulted in difficulty understanding the subject matter. The remaining ten people (15.625%) considered their difficulties in understanding the material due to learning resources. It is still very difficult to get, so rely on the explanation in class. As for the data in the picture above, it is more likely to admit that it is difficult to answer questions correctly because their understanding of the material is still lacking. The material they have is only a basic formula that is difficult to use in problem-solving applications; in other words, students have not become physicists who are characterized do not yet have the extensive capabilities that professional physicists usually do, where answers are only based on individual consent, not due to theoretical analysis or concepts of force and motion (Scott & Schumayer, 2018; Smith & Wittmann, 2008). The results of this qualitative data analysis align with the quantitative data presented, where a conclusion can be drawn that, on average, students have low conceptual mastery skills in force and motion.

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

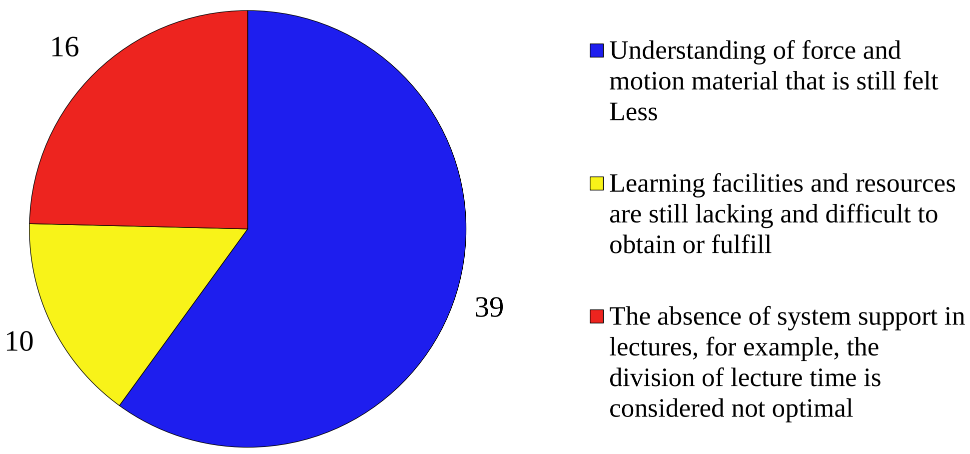


Figure 5. The results of the interview are deeper into student difficulties

CONCLUSION

From the research process and data analysis described, it can be concluded that, on average, students of tardis physics, especially the material of force and motion, do not understand well, where students' ability to master concepts is still meager, namely, actually 64.062%. As many as 94% of physics tardis students think that the force and motion material given by the lecturer during the test is challenging, and more than 60.94% of students thought it was due to the ability of the material force and motion that they had was still lacking. Observation results indicate that there is still a need for a learning model appropriate for online and offline learning. It is hoped that future researchers can use suitable learning models to improve student learning outcomes in good physical lectures, especially learning that is done online.

REFERENCES

Aycock, A., Garnham, C., & Kaleta, R. (2002). Lessons Learned from the Hybrid Course Project. *Teaching with Technology Today*, *8*(6), 9–21.

Bayraktar, S. (2009). Misconceptions of Turkish pre-service teachers about force and motion. *International Journal of Science and Mathematics Education*, *7*(2), 273–291. https://doi.org/10.1007/s10763-007-9120-9

Bohori, M., & Liliawati, W. (2019). Analisis penguasaan konsep siswa menggunakan Rasch Model pada materi usaha dan energi. *Prosiding Seminar Nasional Fisika*, *0*. http://proceedings.upi.edu/index.php/sinafi/article/view/579

Brookes, D. T., & Etkina, E. (2009). "Force," Ontology, and Language. *Physical Review Special Topics - Physics Education Research*, *5*(1), 1–13. https://doi.org/10.1103/PhysRevSTPER.5.010110

Cremers, P. H. M., Wals, A. E. J., Wesselink, R., Nieveen, N., & Mulder, M. (2014). Self-directed lifelong learning in hybrid learning configurations. *International Journal of Lifelong Education*, *33*(2), 207–232. https://doi.org/10.1080/02601370.2013.838704

Creswell, J. W. (2012). *Planning, Conducting, and Evaluating Quantitative and Qualitative Research*.

Dong, C., Cao, S., & Li, H. (2020). Young children's online learning during COVID-19 pandemic: Chinese parents' beliefs and attitudes. *Children and Youth Services Review*, *118*(June), 105440. https://doi.org/10.1016/j.childyouth.2020.105440

Goodhew, L. M., Robertson, A. D., Heron, P. R. L., & Scherr, R. E. (2021). Students' context-sensitive use of conceptual resources: A pattern across different styles of question about mechanical waves. *Physical Review Physics Education Research*, *17*(1), 10137. https://doi.org/10.1103/physrevphyseducres.17.010137

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

Gurcay, D., & Gulbas, E. (2015). Development of three-tier heat, temperature and internal energy diagnostic test. *Research in Science and Technological Education*, *33*(2), 197–217. https://doi.org/10.1080/02635143.2015.1018154

Hapke, H., Lee-Post, A., & Dean, T. (2020). 3-in-1 Hybrid Learning Environment. *Marketing Education Review*, *00*(00), 1–8. https://doi.org/10.1080/10528008.2020.1855989

Hariharasudan, A., & Kot, S. (2018). A scoping review on Digital English and Education 4.0 for Industry 4.0. *Social Sciences*, *7*(11), 0–13. https://doi.org/10.3390/socsci7110227

Helms, S. A. (2014). Blended/hybrid courses: a literature review and recommendations for instructional designers and educators. *Interactive Learning Environments*, *22*(6), 804–810. https://doi.org/10.1080/10494820.2012.745420

Kibirige, I., & Mamashela, D. (2022). *High school students ' misconceptions about force : what changed the flipped class experience ? 10*(March), 0–3.

Kohl, P. B., & Finkelstein, N. D. (2008). Patterns of multipe representation use by experts and novices during physics problem solving. *Physical Review Special Topics - Physics Education Research*, *4*(1), 1–13. https://doi.org/10.1103/PhysRevSTPER.4.010111

Lestari, Syafril, S., Latifah, S., Engkizar, E., Damri, D., Asril, Z., & Yaumas, N. E. (2021). Hybrid learning on problem-solving abiities in physics learning: A literature review. *IOP Conference Series: Earth and Environmental Science*, *1796*(1). https://doi.org/10.1088/1742-6596/1796/1/012021

Lin, O. (2008). Student Views of Hybrid Learning. *Journal of Computing in Teacher Education*, *25*(2), 57–66. https://doi.org/10.1080/10402454.2008.10784610

Maya, F., Yani, F., Rohmah, S., Purnama, B. Y., & Zohuri, B. (2023). *Analysis of Students ' Understanding of Concepts in Straight Motion Material in Physics Learning*. *2*(1), 1–2.

Meiliani, M., Tanti, T., & Sulman, F. (2021). Student Resources On Newton's Lawa Concepts Reviewing From Gender: Identification Using Open-Ended Question. *Indonesia Journal of Science and Mathematics Education*, *04*(November), 324–332. https://doi.org/10.24042/ijsme.v4i3.10177

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. *American Journal of Physics*, *70*(12), 1259–1268. https://doi.org/10.1119/1.1514215

Mestre, J. P., Docktor, J. L., Strand, N. E., & Ross, B. H. (2011). Conceptual Problem Solving in Physics. In *Psychology of Learning and Motivation - Advances in Research and Theory* (Vol. 55). Elsevier Inc. https://doi.org/10.1016/B978-0-12-387691-1.00009-0

Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *International Journal of Educational Research Open*, 100012. https://doi.org/10.1016/j.ijedro.2020.100012

Nisa', F., Yuliati, L., & Mufti, N. (2019). Miskonsepsi Konsep Gerak Satu dan Dua Dimensi Siswa SMA. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *4*(10), 1380. https://doi.org/10.17977/jptpp.v4i10.12874

Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computers and Education: Artificial Intelligence*, *2*(April), 100020. https://doi.org/10.1016/j.caeai.2021.100020

Putra, M. I. J., Junaid, M., & Sulman, F. (2021). The Ability of the Question and Answer (Q&A) Method with the Help of Learning Videos against Student Learning Outcomes amid the Covid-19 Pandemic. *EDUKATIF: Jurnal Ilmu Pendidikan*, *3*(5), 2160–2169. https://doi.org/https://doi.org/10.31004/edukatif.v3i5.768

Reyza, M., Taqwa, A., Suyudi, A., & Sulman, F. (2023). *Kinematics students ' conceptual understanding in mathematical and visual representations : Is it different ? Kinematics Students ' Conceptual Understanding in Mathematical and Visual Representations : Is It Different ? 050005*(January).

Riantoni, C., & Yelianti, U. (2023). Analysis of Student Problem Solving Processes in Physics. *International Journal of Education and Teaching Zone*, *2*(1), 1–2.

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

Rosbottom, J. (2001). Hybrid learning - A safe route into web-based open and distance learning for the computer science teacher. *Proceedings of the Conference on Integrating Technology into Computer Science Education, ITiCSE*, 89–92. https://doi.org/10.1145/377435.377493

Rozal, E., Ananda, R., Zb, A., Fauziddin, M., & Sulman, F. (2021). The Effect of Project-Based Learning through YouTube Presentations on English Learning Outcomes in Physics. *AL-ISHLAH: Jurnal Pendidikan*, *13*(3), 1924–1933. https://doi.org/10.35445/alishlah.v13i3.1241

Scott, T. F., & Schumayer, D. (2018). Central distractors in Force Concept Inventory data. *Physical Review Physics Education Research*, *14*(1), 10106. https://doi.org/10.1103/PhysRevPhysEducRes.14.010106

Shah, S. S., Shah, A. A., Memon, F., Kemal, A. A., & Soomro, A. (2021). Online learning during the COVID-19 pandemic: Applying the self-determination theory in the 'new normal.' *Revista de Psicodidáctica*, *xxxx*. https://doi.org/10.1016/j.psicoe.2020.12.003

Shatalebi, B., Sharifi, S., & Javadi, H. (2011). An integrative teaching model in the globalization era with a teaching technology orientation. *Procedia - Social and Behavioral Sciences*, *28*. https://doi.org/10.1016/j.sbspro.2011.11.036

Shea, T., Cooper, B. K., de Cieri, H., & Sheehan, C. (2012). Evaluation of a perceived organisational performance scale using Rasch model analysis. *Australian Journal of Management*, *37*(3), 507–522. https://doi.org/10.1177/0312896212443921

Singh, C., & Schunn, C. D. (2009). Connecting three pivotal concepts in K-12 science state standards and maps of conceptual growth to research in physics education. *J. Phys. Tchr. Educ. Online*, *5*(2).

Smith, T. I., & Wittmann, M. C. (2008). *Applying a resources framework to analysis of the Force and Motion Conceptual Evaluation*. *September*, 1–12. https://doi.org/10.1103/PhysRevSTPER.4.020101

Sofna, A., Sakinah, Y., & Pentang, J. T. (2023). Analysis of Student Learning Interest In Physics Subject In Force Material. *International Journal of Education and Teaching Zone*, *2*(1), 1–2.

Stewart, J., Drury, B., Wells, J., Adair, A., Henderson, R., Ma, Y., Pérez-Lemonche, Á., & Pritchard, D. (2021). Examining the relation of correct knowledge and misconceptions using the nominal response model. *Physical Review Physics Education Research*, *17*(1), 1–15. https://doi.org/10.1103/PhysRevPhysEducRes.17.010122

Stoen, S. M., McDaniel, M. A., Frey, R. F., Hynes, K. M., & Cahill, M. J. (2020). Force concept inventory: More than just conceptual understanding. *Physical Review Physics Education Research*, *16*(1), 10105. https://doi.org/10.1103/PhysRevPhysEducRes.16.010105

Sulman, F. (2012). *Pengaruh Model Kooperatif Tipe Problem Possing dan Motivasi Awal Siswa Kelas XI SMA Negeri 12 Padang.*

Sulman, F. (2019). Application of Cooperative Problem Posing and Prior Motivation Towards Students Learning Outcomes. *Indonesian Journal of Educational Research (IJER)*, *4*(2), 93–96. https://doi.org/10.30631/ijer.v4i2.126

Sulman, F., Sutopo, S., & Kusairi, S. (2021). FMCE-PHQ-9 Assessment with Rasch Model in Detecting Concept Understanding , Cheating , and Depression amid the Covid-19 Pandemic. *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, *6*(2), 297–309. https://doi.org/10.24042/tadris.v6i2.9273

Sulman, F., Tanti, T., Habibi, M., & Zb, A. (2021). Pengaruh Media Animasi Berkarakter Islami Terhadap Hasil Belajar Pengetahuan Bumi dan Antariksa. *Edumaspul: Jurnal Pendidikan*, *5*(1), 135–146. https://doi.org/10.33487/edumaspul.v5i1.1044

Sulman, F., Taqwa, M. R. A., Aminah Zb, A. Z., Rafzan, R., & Fikri, A. (2020). The Effect of Mathematical Connections on the Mastery of Probability Material. *Edumatika : Jurnal Riset Pendidikan Matematika*, *3*(2), 147–157. https://doi.org/10.32939/ejrpm.v3i2.645

Sulman, F., Yuliati, L., Kusairi, S., & Hidayat, A. (2022). Hybrid Learning Model : Its Impact on Mastery of Concepts and Self- Regulation in Newton ' s Second Law Material. *Kasuari: Physics Education Journal*, *5*(1), 65–74. https://doi.org/https://doi.org/10.37891/kpej.v5i1.273

ISSN 2406-9205 (print), ISSN 2477-4820 (online)

Sulman, F., Yuliati, L., Purnama, B. Y., & Arief, M. R. (2022). *Creativity In Deriving The Fermi-Dirac Equation Through STEAM Approaches*. *10*(3). https://doi.org/10.20527/bipf.v10i3.13182

Tao, H. feng, Paszke, W., Rogers, E., Gałkowski, K., & Yang, H. zhong. (2018). Modified Newton method based iterative learning control design for discrete nonlinear systems with constraints. *Systems and Control Letters*, *118*, 35–43. https://doi.org/10.1016/j.sysconle.2018.05.007

Taqwa, R. A. T., Sulman, F., & Faizah, R. (2022). College Students ' Conceptual Understanding of Force and Motion : Research Focus on Resource Theory College Students ' Conceptual Understanding of Force and Motion : Research Focus on Resource Theory. *Journal of Physics: Conference Series*, *2309*(1), 012073. https://doi.org/10.1088/1742-6596/2309/1/012073

Thornton, R. K., & Sokoloff, D. R. (1998). Assessing student learning of Newton's laws: The Force and Motion Conceptual Evaluation and the Evaluation of Active Learning Laboratory and Lecture Curricula. *American Journal of Physics*, *66*(4), 338–352. https://doi.org/10.1119/1.18863

Tseng, W. T., Su, T. Y., & Nix, J. M. L. (2019). Validating Translation Test Items via the Many-Facet Rasch Model. *Psychological Reports*, *122*(2), 748–772. https://doi.org/10.1177/0033294118768664

Veugen, M. J., Gulikers, J. T. M., & den Brok, P. (2021). We agree on what we see: Teacher and student perceptions of formative assessment practice. *Studies in Educational Evaluation*, *70*(October 2020), 101027. https://doi.org/10.1016/j.stueduc.2021.101027

Wells, J., Henderson, R., Stewart, J., Stewart, G., Yang, J., & Traxler, A. (2019). Exploring the structure of misconceptions in the Force Concept Inventory with modified module analysis. *Physical Review Physics Education Research*, *15*(2), 20122. https://doi.org/10.1103/PhysRevPhysEducRes.15.020122

Yusuf, I., Zb, A., & Rozal, E. (2022). The Understanding Mathematical Communication Concepts and Skills : Analysis of the Ability of Prospective Physics Teachers ? *International Journal of Education and Teaching Zone*, *1*(2), 8–10. https://doi.org/https://doi.org/10.57092/ijetz.v1i2.34

Zakwandi, R., Wulansari, P., Maula, A. R., & Hasan, S. (2022). Learning Reflection During Covid-19 Pandemic : Teacher Perception Toward Google Form Based Test. *International Journal of Education and Teaching Zone*, *1*(2), 8–10. https://doi.org/https://doi.org/10.57092/ijetz.v1i2.42

Zb, A., Novalian, D., Ananda, R., Habibi, M., & Sulman, F. (2021). *DISTANCE LEARNING WITH STEAM APPROACHES: Is Effect On The Cognitive Domain?* *6*(2), 129–140.

Zb, A., Setiawan, M. E., Rozal, E., & Sulman, F. (2021). Investigating Hybrid Learning Strategies: Does it Affect Creativity? *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *7*(4), 868–875. https://doi.org/10.33394/jk.v7i4.4063

Zb, A., Setiawan, M. E., & Sulman, F. (2020). Pengaruh E-Learning Berbasis Schoology Berbantuan WhatsApp Group terhadap Hasil Belajar Ditengah Pandemi Covid-19. *Al-Khidmah*, *3*(2), 55–60. https://doi.org/10.29406/al-khidmah.v3i2.2282

ISSN 2406-9205 (print), ISSN 2477-4820 (online)