Analysis of Students' Mastery of Concepts in Newton's Second Law Material through the Rasch Model

Boby Syefrinando[1], Fauzan Sulman[2]✉

Universitas Islam Negeri Sulthan Thaha Saifuddin Jambi, Indonesia[1,2]

e-mail : boby-syefrinando@uijambi.ac.id[1], fauzansulman@uinjambi.ac.id[2]

Abstrak

Penelitian bertujuan untuk melihat pemahaman konsep siswa pada materi hukum kedua Newton melalui model Rasch. Penelitian ini dilakukan pada mahasiswa pendidikan fisika Universitas Islam Negeri Sulthan Thaha Saifuddin Jambi yang berjumlah 29 mahasiswa yang aktif pada bulan Agustus 2023. Metode penelitian yang digunakan adalah metode penelitian deskriptif kualitatif dengan mengacu pada tata cara pengorganisasian dan pelaksanaan observasi, dimana peneliti tidak melakukan perlakuan khusus untuk melakukan perubahan pada diri siswa, namun melihat pada kondisi nyata yang dimiliki siswa dengan kondisi modern. Instrumen terdiri dari 45 item yang berkaitan dengan gaya dan gerak. Pemilihan butir soal untuk memperoleh butir soal yang sesuai menggunakan program Winsteps 3.65.0. Hasil analisis menggunakan Model Rasch menunjukkan 23 item fit. Hasil analisis menunjukkan kemampuan konsep sangat rendah, penguasaan konsep siswa rendah dimana secara persentase 97% memiliki penguasaan konsep rendah, dan hanya 3% yang memiliki kemampuan penguasaan konsep sedang khususnya pada materi Hukum II.

Kata Kunci: Pemahaman Konsep, Intrument Tes Fit, Rasch Model

Abstract

The research aims to see students' conceptual understanding of Newton's second law material through the Rasch model. This research was conducted on physics education students at the Sulthan Thaha Saifuddin Jambi State Islamic University, totaling 29 active students in August 2023. The research method used was a qualitative descriptive research method regarding the procedures for organizing and carrying out observations, where the researcher did not carry out special treatment. to make changes to students, but looking at the real conditions that students have in modern conditions. The instrument consists of 45 items related to force and motion. Selection of questions to obtain appropriate questions using the Winsteps 3.65.0 program. The results of the analysis using the Rasch Model showed 23 fit items. The results of the analysis show that concept ability is very low, students' concept mastery is low where in percentage terms 97% have low concept mastery, and only 3% have moderate concept mastery ability, especially in Law II material.

Keywords: Conceptual Understanding, Instrument Test Fit, Rasch Model

INTRODUCTION

The lecture process in the Tadris Physics study program, in adapting to and at the same time facing changes in educational process patterns in the industrial era 4.0 (Couló, 2020; Liao et al., 2019; Watts et al., 2003), must have a breakthrough that is comprehensive and measured clearly and well. The lecture process must consist of abilities and aspects that can be a conductor in demonstrating students' abilities. In reality, institutions should be the most effective and efficient place of learning, especially in the field of physics education so that children's understanding of concepts can increase. Understanding concepts is of particular concern in physics, one of which is Newton's Second Law (Bao & Fritchman, 2021; Tao et al., 2018; Thornton & Sokoloff, 1998). Various forms of efforts to improve mastery of physics concepts have been carried out both in terms of learning models, developing learning media, and developing assessments in learning. This shows unsatisfactory results so an assessment is needed that can measure accurately. One of the measuring tools used is a precision test in the form of multiple choice test questions because it gives students the opportunity to think about questions that are correct and also possibly incorrect (Hidayati et al., 2023; Scott & Schumayer, 2017). Although it cannot be denied that multiple choice test instruments still have many obstacles and do not seem to be able to measure what they should measure and this causes the need for pathways and criteria in assessment. Assessment of understanding of the concept of Newton's Second Law should be easy to carry out if the measuring instruments used are correct and precise (Adha et al., 2023; Sofna et al., 2023).

To measure mastery of a concept, of course, a chosen test instrument must meet the criteria as a good measuring instrument and is also effective and efficient(Halloun, 2007; Stoen et al., 2020; Sulman, Tanti, et al., 2021; Villalonga-Olives et al., 2021). Most of the instruments used have not been able to achieve maximum results (Masalesi, 2022; Misbah et al., 2022; Nehru et al., 2022; Yusuf et al., 2022). For example, when officers ask to analyze what happens if we dive in an intense place, for students who have interacted with this question it is relatively easy to answer, while students who do not know the phenomenon presented by the lecturer may need a better explanation and understanding of the material. and easy to understand (Kusumawati & Wahyuni, 2022; Sulman et al., 2020; Villalonga-Olives et al., 2021). The lecture process should provide additional data, therefore good assessment is needed in the form of measuring instruments that are able to increase students' mastery of concepts, especially Newton's Second Law in physics education. Correct and accurate data is not only an important factor but can also be an ability that influences students' actual learning outcomes, so that the test questions used are truly able to provide an overview of students' true mastery of concepts (Lin et al., 2015; Lindsey K. Le, 2013; Uzunboylu & Aşıksoy, 2014; Wei et al., 2021; Wells et al., 2019). Having correct and accurate concept mastery information is believed to be an important component in improving better mastery of the material. In fact, nowadays it is very easy for students to get information about the physics material provided, especially Newton's second law(Meltzer, 2005; O'Neil et al., 2020; Scott & Schumayer, 2018; Wells et al., 2020). In lectures, true students are not yet able to maximize the information or material provided by lecturers, especially basic physics courses, especially Newton's second law. Assessment of students' mastery of concepts can actually be seen from classical procedures and also technology, so it can be the perfect combination in measuring students' real abilities (Aldalur & Perez, 2023; Stoen et al., 2020).

In physics lectures, an assessment must be measured in depth in making decisions, so that modern test theory, usually called Item Response Theory, can be a solution to overcome existing weaknesses. in ordinary Classical Test Theory (Ponkilainen et al., 2021; San Martín & Rolin, 2013; Sulman et al., 2023; Sulman, Sutopo, et al., 2021). Item response theory models each participant's response to each item in a test. Response theory in determining the characteristics of the model that can be used is the Rasch model (Sulman et al., 2023; Sulman, Sutopo, et al., 2021). With the test instrument carried out using Rasch modeling, the aim is to measure the objective (measurement objective) to measure the measurement, but to measure the results depending on who is being measured (test-dependent scoring). The percentage or number of correct answers on a test based on the subject being measured (dependent sample) is descriptive and applies to all subjects. Objective measurements

produce data that does not depend on the type of subject, characteristics of the assessor, and characteristics of the measuring instrument. This research reference uses Rasch modeling to analyze test instruments developed in accordance with the learning perspective assessment with 45 test items modified from available FMCE questions, where the test questions are only administered during the test and are not distributed after the test to maintain the confidentiality of the questions. The instrument is in the form of test questions developed using the Rasch Model with online questions with the Winstep program version 3.65.0 which can see question bias and can detect questions in answering questions correctly during the online test so it is not expected that some students will feel disadvantaged by inaccurate and inaccurate measurements (Shea et al., 2012; Sulman et al., 2023; Sulman, Sutopo, et al., 2021; Zehirlioglu & Mert, 2020) and fair in assessing his learning abilities.

In this research, the researcher tries to describe the mastery of physics students' concepts in Newton's Second Law material through a question item using the Rasch Model approach which is expected to be able and able to provide students with accurate measurements, especially Newton's Second Law material. Mastery of concepts will be measured by analyzing questions, namely 45 test questions given in a classical manner which are then formed into fit questions, where questions that have been modeled as fit questions or questions that are good and effective in measuring students' mastery of concepts, especially Newton's Second Law, will become questions. who are truly able to explore how students actually understand or master concepts, especially in Newton's Second Law material, so that it can become a fact in improving and perfecting especially Newton's Second Law material and in general in basic physics courses, especially in physics courses. The process clearly shows that the role of the Rasch model that researchers use is an effective and efficient means for changing the educational paradigm which is able to increase understanding and detect student understanding which so far requires several days of observation, with assessments that are followed by standards or Rasch model views(Nehru et al., 2022; Sulman, Yuliati, Kusairi, et al., 2022; Sulman, Yuliati, Purnama, et al., 2022a). all data will be retrieved easily and effectively. thus making it easier for education to find out students' true understanding of Newton's Second Law, which can then be used as input for physics education both nationally and internationally.

METHOD

The research method used is a descriptive qualitative research method with reference to the procedures for organizing and conducting observations, where the researcher does not carry out special treatment to make a change in the students, but looks at the real conditions that the students have with modern instruments.This research was carried out at the analysis stage of the FMCE test instrument using the Rasch model. The test subjects for this research were 29 students who had taken basic physics courses at the Sulthan Thaha Saifuddin Jambi State Islamic University. Quantitative data analysis with the help of the Winsteps program Version 3.65.0. The Winsteps Program Version 3.65.0 was used to obtain item parameters that fit the Rasch model. Determination of reliability is seen from the magnitude of Item Reliability and overall item reliability which is indicated by the magnitude of the Cronbach alpha value, while the item limit is declared according to the model if it has an MNSQ Outfit of 0.5 to 1.5; ZSTD clothing between -2.0 to 2.0; and the correlation value with the total score or point size. correlations ranged from 0.4 to 0.85. After developing the instrument, the 45 test items carried out classically will continue to be analyzed using the Rasch model and the modeled questions will be obtained (fit questions) which will then be continued by analyzing and concluding the understanding of the Siawa concept using the Winsteps Version 3.65.0 program. by seeing how students master concepts, especially Newton's Second Law material. mastery of concepts in basic physics, especially Newton's second law, is actually a must for prospective physics education teachers, so that all abilities at the advanced level can be better, this is an indication that it is very important for basic abilities to be mastered very well. so that detecting as early as possible students' basic understanding, especially in Newti's Second Law and in general in basic physics courses can be considered a necessity.

RESULTS AND DISCUSSION

Results

In the research that has been carried out, the researchers actually want to describe an understanding of the concepts of physics students who will be active in August 2023, by using a modern assessment where the process will refer to Rasch modeling (Creswell, 2012; Njie & Asimiran, 2014). As for the results of the research that has been carried out, there are 2 data observed where the two data have an inseparable relationship with each other. This data is data on how the test questions are formed first which will be analyzed using the wisntep program with reference to the Rasch model to get fit data (fit question items), which will then be carried out further analysis to get data about students' understanding of concepts in Law II material. Newton. The data that researchers obtained for appropriate questions (fit question items) is as shown in Table 1.

```
-----------------------------------------------------------------------
PERSON: REAL SEP.: .00  REL.: .00 ... ITEM: REAL SEP.: .97  REL.: .48

       ITEM STATISTICS:  MISFIT ORDER

-----------------------------------------------------------------------
|ENTRY   TOTAL                  MODEL|  INFIT  |  OUTFIT  |PTMEA|EXACT MATCH|       |
|NUMBER  SCORE COUNT MEASURE  S.E. |MNSQ ZSTD|MNSQ ZSTD|CORR.| OBS%  EXP%| ITEM  |
|-----------------------------------+---------+---------+-----+-----------+-------|
|  16      6    29   -.16    .48|1.27  1.0|1.50  1.6|A-.14| 75.0  79.3| Soal 36|
|  23      8    29   -.58    .43|1.18   .9|1.13   .6|B .08| 67.9  72.9| Soal 45|
|   2     17    29  -2.03    .40|1.18  1.4|1.16  1.0|C .14| 50.0  64.4| Soal 10|
|  15      6    29   -.16    .48|1.10   .5|1.04   .2|D .15| 75.0  79.3| Soal 33|
|  21      7    29   -.38    .45|1.10   .5|1.04   .2|E .17| 71.4  76.1| Soal 42|
|  18      2    29   1.17    .75|1.08   .3|1.10   .4|F .08| 92.9  92.9| Soal 38|
|  14      5    29    .08    .51|1.08   .4|1.00   .0|G .18| 78.6  82.5| Soal 32|
|   5      2    29   1.17    .75|1.02   .2| .48  -.1|H .20| 92.9  92.9| Soal 15|
|  12      7    29   -.38    .45|1.02   .1| .47  -.2|I .28| 71.4  76.1| Soal 26|
|   8      8    29   -.58    .43| .98  -.1| .49  -.2|i .31| 75.0  72.9| Soal 21|
|   1      4    29    .36    .56| .93  -.1| .42  -.1|h .29| 85.7  85.7| Soal 9 |
|  17      7    29   -.38    .45| .91  -.3| .43  -.2|g .35| 78.6  76.1| Soal 37|
|  19      8    29   -.58    .43| .89  -.5| .43  -.2|f .40| 75.0  72.9| Soal 40|
|  10      3    29    .71    .63| .87  -.1| .43  -.1|e .35| 89.3  89.3| Soal 23|
|  13      3    29    .71    .63| .87  -.1| .44  -.2|d .34| 89.3  89.3| Soal 31|
|   4      3    29    .71    .63| .85  -.2| .45  -.1|c .40| 89.3  89.3| Soal 14|
|   9      3    29    .71    .63| .85  -.2| .46  -.2|b .40| 89.3  89.3| Soal 22|
|  11      7    29   -.38    .45| .83  -.7| .41 -1.0|a .49| 78.6  76.1| Soal 24|
|-----------------------------------+---------+---------+-----+-----------+-------|
| MEAN    5.9  29.0   .27    .81|1.00   .2| .94   .0|     | 79.2  81.0|       |
| S.D.    6.2   .0   1.95    .54| .13   .5| .22   .6|     | 10.5   8.0|       |
-----------------------------------------------------------------------
```

Figure 1. The results of the analysis of test items

Figure 1 above clearly shows how the test questions are formed using Rasch modeling. Rasch modeling will create a form of questions that is actually able to identify precisely and accurately how a question is truly able to interact with the question itself and is also able to interact or have an understanding and a straight line with students who will take the test, where with the questions that Formed are called Fit Questions which are able to present questions well and effectively in taking measurements. In everyday life, actually presenting questions is done by looking for good questions using classical analysis techniques or commonly known as empirical validity analysis by looking for the differentiating power of the questions, the difficulty index of the questions, the validity of the questions and also the reliability of the questions. Sometimes this is very helpful to show quality questions, but we have to understand that if the population and sample size is very large, this is very difficult and a bit troublesome, because this is the quality of the fit questions using Rasch modeling which is very good and can be measured accurately. Good and quality assessment can encourage learning outcomes

that are truly in accordance with students' abilities(Meiliani et al., 2021; Sulman, Tanti, et al., 2021; Zb, Novalian, Rozal, et al., 2021; Zb, Setiawan, et al., 2021), so that the measurements carried out are truly capable of not only knowing students' abilities but can be a guide for lecturers or teachers in carrying out the next action process so that students become better and easily deepen knowledge material at the next level(Meiliani et al., 2021; Putra et al., 2021; Rozal et al., 2021; Sulman et al., 2020; Sulman, Tanti, et al., 2021; Sulman, Yuliati, Purnama, et al., 2022b; Zb, Novalian, Ananda, et al., 2021; Zb, Novalian, Rozal, et al., 2021; Zb, Setiawan, et al., 2021). Good knowledge can only be obtained from the results of good teaching, and it can also be stated that good teaching must be supported by good assessment, if both are fulfilled it will make learning really good and effective(Nehru et al., 2022; Yusuf et al., 2022; Zakwandi et al., 2022; Zb et al., 2022). so that the results obtained are students who are truly able to understand the material well.The research process was continued to obtain data on students' understanding of Newton's Law II material which can be seen in Table 2.
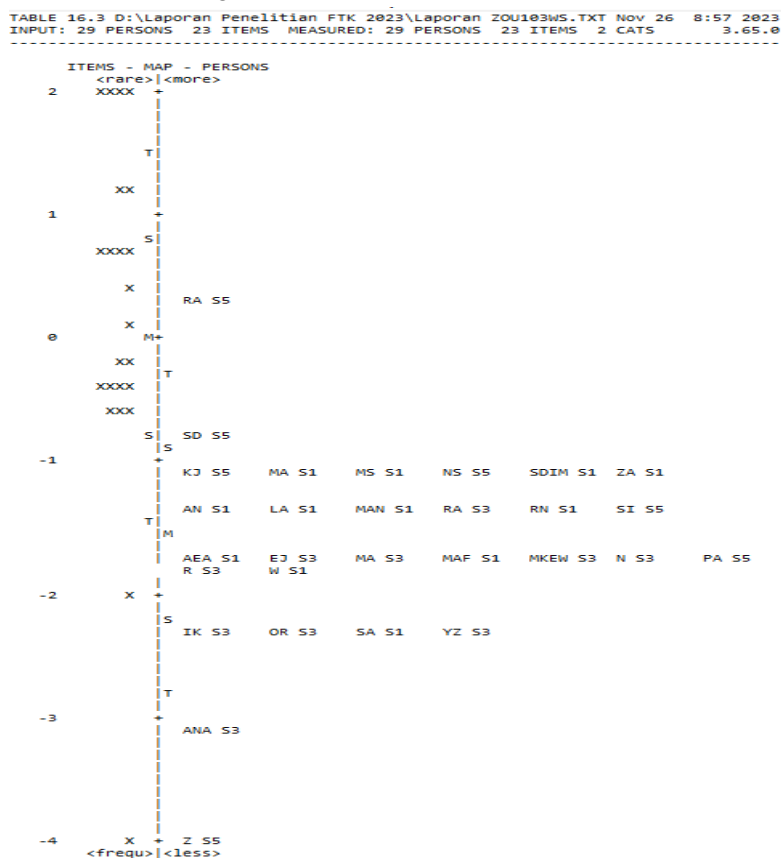

Figure 2. Students' understanding ability on test questions on Newton's Second Law material

Discussion

Based on data analysis using Winsteps software, there are 23 items that fit the Rasch model and 22 other items that do not fit the Rasch model. It can be said that the abilities of Tadris Physics students at Sulthan Thaha Saifuddin Jambi State Islamic University, especially Newton's second law, are far below the level of difficulty; in other words, in answering all the questions it is difficult for students to answer all the questions correctly. So that students with low ability only answer questions with low distinguishing power and cannot do the most difficult questions, and the data can also be stated that the level of consistency of students' answers is in the sufficient or consistent category in describing the level of student ability, especially in Newton's Second Law material. Children's motivation is very important and can have a strong influence on the results to be achieved (Meiliani et al., 2021; Sulman, 2019; Sulman, Yuliati, Purnama, et al., 2022a, 2022b). In analyzing the data that has been presented or obtained in the research, it can be stated that the test instrument used is suitable for

measuring students' mastery of concepts, especially students' Newton's Second Law in Basic Physics courses. It can be ascertained that the data has the possibility of a rational value that is truly able to describe students' mastery of concepts, where the test item questions that are formed are 23 items which are good in carrying out the process of measuring Newton's second law material. In other words, as a whole the questions or items are in accordance with the Rasch model and can be used as an instrument to test students' conceptual understanding of Newton's Second Law material.

The above shows the ability of the Rasch Model in developing assessment instruments. An item limit is declared to fit the model if it meets one or both of the following conditions. The first condition is that the Outfit MNSQ value is between 0.5 and 1.5; The ZSTD value of clothing is between -2.0 to 2.0; and the correlation value of items with the total score lies between 0.4 to 0.85. This is used to explain that the questions developed are truly a measuring tool that is not just a final exam, but an assessment that can help lecturers in lectures. Of course, in the research that has been carried out, all of these measurements have clearly been fulfilled and are considered truth or success in forming good (fit) test items.

In this research, especially the mastery of the concept of Newton's Second Law, which is an assessment using the Rasch model, there are actually several things that can be taken into account indirectly and have special characteristics where the raw data must be converted into odds ratio form as valid data, through the Rasch item model, it can change the form of an ordinal response into a ratio with a better level of accuracy in terms of the principle of probability which is able to describe the greatest probability or tendency of a test item to become a guide in analyzing questions. Basically, test items that have been formed using Rasch modeling actually have a possibility of truth or error of the selected test items because the Rasch model not only looks at good items but also from the perspective of the person working on the instrument so that the instrument can be consistent in measure without being influenced by other factors(Reyza et al., 2023; Sulman, Sutopo, et al., 2021; Sulman, Yuliati, Purnama, et al., 2022b; Sulman et al., 2023; Zb, Novalian, Ananda, et al., 2021). so that the questions that are formed are very capable of measuring students' mastery of concepts, especially Newton's Second Law. The number of test questions, namely 23 test items, were fit after analysis using Rasch modeling, especially for Newton's Second Law.

Understanding Student Concepts on Force and Motion Materials

Analysis of students' conceptual understanding of Newton's second law which was developed using the Rasch model for tardis physics students at Sulthan Thaha Saifuddin State Islamic University, Jambi from 23 question items that were fit, so that it could become an appropriate measuring tool which was then analyzed again using the Winstep application so that it could explain and describe in detail how students actually master concepts in Newton's Second Law material, so that it is clear the actual situation or state of student mastery of concepts that are actually in Newton's Second Law, in other words, students' mastery of Newton's Second Law can be seen at the level possessed by students compared to their level. The difficulty given, between the test questions given and also the students' abilities.

The data in Figure 2 shows that the conceptual understanding ability of Tadris physics students at Sulthan Thaha Saifuddin Jambi State Islamic University in working on test questions on Newton's Second Law material that has been developed can be developed and analyzed from the winsteps output in that section, namely the Wright map. Students' information about the ideas of force and motion is still shallow. This can be seen from the analysis results where FMCE has a much higher level of difficulty compared to students' abilities. This value can be seen from the 45 questions given, only 23 test items can be used for further analysis, especially students' mastery of concepts in Newton's Second Law material. The results of the analysis show that concept ability is very low, students' concept mastery is low where in percentage terms 97% have low concept mastery, and only 3% have moderate concept mastery ability, especially in Law II material. However, the researcher realizes that there are many shortcomings in this research, where the questions used are international standards which are sometimes very difficult for students to accept, and also the small population means the data cannot be seen on

a larger scale, so the researcher hopes for further research. There are other researchers who carry out global analysis which is able to support general assessments, because the Rasch model will be very effective if carried out on a large scale and has high standards. The understanding of the concepts obtained by researchers is believed to be able to make a big and real contribution to the development of physics education. Conceptual understanding is basically a path that has been traversed by students in gaining knowledge, in other words the amount of conceptual understanding that students have in Newton's Second Law material clearly shows the basic abilities of physics education students in understanding the material, as well as a refinement that is able to separate students based on several levels of mastery, so that later in the learning process it can become an introduction to students about the real understanding that must be fulfilled by lecturers in providing knowledge(Misbah et al., 2022; Rahim & Nadira, 2022; Yusuf et al., 2022), so that learning related to Newton's Second Law material can run better and is not fragmented so that students will have difficulty understanding newly learned knowledge. Researchers believe that students' difficulties will be resolved by carrying out analysis with appropriate test instruments referring to the Rasch model indicators, so that the assessment obtained is truly a good and quality assessment.

CONCLUSION

In the research that has been carried out, the test instruments used in Newton's Second Law material have been obtained using the Rasch model, namely from the 45 test items used, measuring students' mastery of concepts in Newton's second law material. This instrument consists of 45 items related to Newton's Second Law and is tested on students directly or classically. Selection of questions to obtain appropriate questions using the Winsteps 3.65.0 program. The results of the analysis using the Rasch Model showed 23 fit items. The results of the analysis show that concept ability is very low, students' concept mastery is low where in percentage terms 97% have low concept mastery, and only 3% have moderate concept mastery ability, especially in Law II material. It is recommended that future researchers, when using assessments that are standardized as researchers, must really carry out in-depth analysis and also validate with experts so that questions are actually formed that are accurate and appropriate to the student's character or abilities.

ACKNOWLEDGEMENT

DAFTAR PUSTAKA

Adha, A. F., Rera, A., & Farisi, S. Al. (2023). Analysis of the TGT Cooperative Learning Model in Physics Learning : in terms of the Implementation of Procedures and Principles. *International Journal of Education and Teaching Zone*, *2*(1), 1–2. https://doi.org/https://10.57092/ijetz.v2i1.70

Aldalur, I., & Perez, A. (2023). Gamification and discovery learning: Motivating and involving students in the learning process. *Heliyon*, *9*(1), e13135. https://doi.org/10.1016/j.heliyon.2023.e13135

Bao, L., & Fritchman, J. C. (2021). Knowledge integration in student learning of Newton's third law: Addressing the action-reaction language and the implied causality. *Physical Review Physics Education Research*, *17*(2), 20116. https://doi.org/10.1103/PhysRevPhysEducRes.17.020116

Couló, A. C. (2020). Encyclopedia of Educational Philosophy and Theory. *Encyclopedia of Educational Philosophy and Theory*, 1–6. https://doi.org/10.1007/978-981-287-532-7

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

Halloun, I. A. (2007). *Evaluation of the Impact of the New Physics Curriculum on the Conceptual Profiles of Secondary Students*. 1–25.

3015 *Analysis of Students' Mastery of Concepts in Newton's Second Law Material through the Rasch Model - Boby Syefrinando, Fauzan Sulman*
DOI: https://doi.org/10.31004/edukatif.v5i6.6169

http://www.halloun.net/index.php?option=com_content&task=view&id=4&Itemid=6

Hidayati, R. A., Reyza, M., & Taqwa, A. (2023). Computer Based Recitation Program Development With Feed Back i n Newton ' s Law Topic. *International Journal of Education and Teaching Zone*, *2*(1), 1–2. https://doi.org/10.57092/ijetz.v2i1.49

Kusumawati, M., & Wahyuni, P. (2022). Investigating the Use of Phet Simulation as a Substitute for Practical Tools in Understanding the Concept of Static Electricity. *International Journal of Educationa and Teaching Zone*, *1*(1), 20–25.

Liao, L., Du, M., Wang, B., & Yu, Y. (2019). The Impact of Educational Investment on Sustainable Economic Growth in Guangdong , China : A Cointegration and Causality Analysis. *Sustainability*, *11*(766). https://doi.org/10.3390/su11030766

Lin, T. J., Liang, J. C., & Tsai, C. C. (2015). Identifying Taiwanese University students' physics learning profiles and their role in physics learning self-efficacy. *Research in Science Education*, *45*(4), 605–624. https://doi.org/10.1007/s11165-014-9440-z

Lindsey K. Le. (2013). Teacher-Efficacy for using HOTS Pedagogy in the Classroom Teacher-Efficacy for using HOTS Pedagogy in the Classroom. *Master's Theses: University of Connecticut*, 1–65.

Masalesi, A. K. (2022). Resource Identification and Level of Understanding of Particle Dynamics Concepts. *International Journal of Education and Teaching Zone*, *1*(2), 8–10. https://doi.org/https://doi.org/10.57092/ijetz.v1i2.48

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. (2005). Relation between students' problem-solving performance and representational format. *American Journal of Physics*, *73*(5), 463. https://doi.org/10.1119/1.1862636

Misbah, M., Trisnowati, E., Rahim, A., & Zb, A. (2022). Investigating Problem Solving and Mathematical Connections in Solving the Fermi-Dirac Equation. *International Journal of Education and Teaching Zone*, *1*(2), 8–10. https://doi.org/https://doi.org/10.57092/ijetz.v1i2.36

Nehru, N., Ananda, R., Zb, A., & Novaliyyan, D. (2022). The Analysis of Mathematical Critical Thinking Ability and Mathematical Creativity : Judging from the Process of Deriving the Fermi-Dirac Formula. *International Journal of Education and Teaching Zone*, *1*(2), 8–10. https://doi.org/https://doi.org/10.57092/ijetz.v1i2.33

Njie, B., & Asimiran, S. (2014). Case Study as a Choice in Qualitative Methodology. *IOSR Journal of Research & Method in Education (IOSRJRME)*, *4*(3), 35–40. https://doi.org/10.9790/7388-04313540

O'Neil, J. M., Newton, R. J., Bone, E. K., Birney, L. B., Green, A. E., Merrick, B., Goodwin-Segal, T., Moore, G., & Fraioli, A. (2020). Using urban harbors for experiential, environmental literacy: Case studies of New York and Chesapeake Bay. *Regional Studies in Marine Science*, *33*, 100886. https://doi.org/10.1016/j.rsma.2019.100886

Ponkilainen, V. T., Miettinen, M., Sandelin, H., Lindahl, J., Häkkinen, A. H., Toom, A., Tillgren, T., Ilves, O., Latvala, A. O., Ahonen, K., Sirola, T., Sampo, M., Väistö, O., & Repo, J. P. (2021). Structural validity of the Finnish Manchester-Oxford Foot Questionnaire (MOXFQ) using the Rasch model. *Foot and Ankle Surgery*, *27*(1), 93–100. https://doi.org/10.1016/j.fas.2020.02.012

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

Rahim, A., & Nadira, N. (2022). Application of Model Group Investigation based on Experiments Against Student Academic Skills. *International Journal of Education and Teaching Zone*, *1*(2), 8–10.

3016 *Analysis of Students' Mastery of Concepts in Newton's Second Law Material through the Rasch Model -*
Boby Syefrinando, Fauzan Sulman
DOI: https://doi.org/10.31004/edukatif.v5i6.6169

https://doi.org/https://doi.org/10.57092/ijetz.v1i2.35

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).

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

San Martín, E., & Rolin, J. M. (2013). Identification of parametric Rasch-type models. *Journal of Statistical Planning and Inference*, *143*(1), 116–130. https://doi.org/10.1016/j.jspi.2012.06.014

Scott, T. F., & Schumayer, D. (2017). Conceptual coherence of non-Newtonian worldviews in Force Concept Inventory data. *Physical Review Physics Education Research*, *13*(1), 1–12. https://doi.org/10.1103/PhysRevPhysEducRes.13.010126

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

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

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.

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. (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., 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*. *9*(1), 95–106.

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

Sulman, F., Yuliati, L., Purnama, B. Y., & Arief, M. R. (2022a). Creativity in Deriving The Fermi-Dirac Equation Through STEAM Approaches. *Berkala Ilmiah Pendidikan Fisika*, *10*(3), 240–254. https://doi.org/10.20527/bipf.v10i3.13182

Sulman, F., Yuliati, L., Purnama, B. Y., & Arief, M. R. (2022b). *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

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

Uzunboylu, H., & Aşıksoy, G. (2014). Research in Physics Education: A Study of Content Analysis. *Procedia - Social and Behavioral Sciences*, *136*, 425–437. https://doi.org/10.1016/j.sbspro.2014.05.353

Villalonga-Olives, E., Kawachi, I., & Rodríguez, A. M. (2021). Rasch model of the bridging social capital questionnaire. *SSM - Population Health*, *14*, 100791. https://doi.org/10.1016/j.ssmph.2021.100791

Watts, E. H., O'Brian, M., & Wojcik, B. W. (2003). Four Models of Assistive Technology Consideration: How Do They Compare to Recommended Educational Assessment Practices? *Journal of Special Education Technology*, *19*(1), 43–56. https://doi.org/10.1177/016264340401900104

Wei, X., Saab, N., & Admiraal, W. (2021). Assessment of cognitive, behavioral, and affective learning outcomes in massive open online courses: A systematic literature review. *Computers and Education*, *163*(December 2020), 104097. https://doi.org/10.1016/j.compedu.2020.104097

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

Wells, J., Henderson, R., Traxler, A., Miller, P., & Stewart, J. (2020). Exploring the structure of misconceptions in the force and motion conceptual evaluation with modified module analysis. *Physical Review Physics Education Research*, *16*(1). https://doi.org/10.1103/Physrevphyseducres.16.010121

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., Ananda, R., & Mensah, B. (2022). The Effect of the STAD Type Cooperative Learning Model With The Help of Crossword Worksheet on Biology Learning Outcomes , Especially The Cognitive Domain. *International Journal of Education and Teaching Zone*, *1*(2), 8–10. https://doi.org/https://doi.org/10.57092/ijetz.v1i2.31

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., Novalian, D., Rozal, E., Sulman, F., & Habibi, M. (2021). STEM Approach in Online Lectures: How Does it Contribute to Cognitive Aspects? *Indonesian Journal of Science and Education*, *5*(2), 88–97. https://doi.org/10.31002/ijose.v5i2.4365

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

Zehirlioglu, L., & Mert, H. (2020). Validity and reliability of the Heart Disease Fact Questionnaire (HDFQ): a Rasch measurement model approach. *Primary Care Diabetes*, *14*(2), 154–160. https://doi.org/10.1016/j.pcd.2019.06.006