IJOLAE Indonesian Journal on Learning and Advanced Education

http://journals.ums.ac.id/index.php/ijolae

IMPAS: Modification of the PAS Questionnaire to Measure Attitudes of High School Students towards Physics in Indonesia

Fatah Kurniawan[1], Achmad Samsudin[2], Didi Teguh Chandra[3], Endang Sriwati[4], Bayram Coştu[5]

[1-3]Faculty of Mathematics and Natural Science, Universitas Pendidikan Indonesia, Indonesia
[4]Senior High School of Malang, Indonesia
[5]Department of Science Education, Yildiz Technical University, Turkey

DOI: 10.23917/ijolae.v5i2.22508
Received: March 17th, 2023. Revised: May 31st, 2023. Accepted: June 2nd, 2023
Available Online: June 3rd, 2023. Published Regularly: May 1st, 2023

Abstract

This study aims to develop an instrument that measures students' attitudes toward physics ang to test its validity and reliability. This instrument was a result of a modification from the PAS Questionnaire, namely IMPAS. This research novelty is making a new instrument that solves the shortcomings in PAS Questionnaire. So, this instrument can be used by teachers and researcers in Indonesia. The target of this IMPAS Questionnaire will be high school students in Indonesia. Using the ADDIE research model, the IMPAS Questionnaire was successfully developed and tested on 156 high school students. The IMPAS Questionnaire consists of 24 positive, negative, neutral positive, and neutral negative statements. The results of the CVR analysis and the Rasch model provide an understanding that the IMPAS Questionnaire has good content and construct validity. So, the IMPAS Questionnaire can be stated to have the ability to measure students' attitudes toward physics accurately. In addition, the results of the Rasch model analysis provide an understanding that the IMPAS Questionnaire has a moderate person reliability, excellent item reliability, and good internal consistency. Therefore, the IMPAS Questionnaire can be stated to have sufficient consistency in measuring students' attitudes toward physics. Thus, the development of an instrument to measure students' attitudes toward physics has been done successfully. Hopefully, this research can contribute to Indonesian education, especially to physics teachers and physics education researchers.

Keywords: ADDIE, attitude instrument, attitude toward physics, rasch model analysis, rasch Rating Scale Model (RSM)

Corresponding Author:
Fatah Kurniawan, Faculty of Mathematics and Natural Science, Universitas Pendidikan Indonesia, Indonesia
Email: kurniawanfatah@upi.edu

1. Introduction

In the 21st century, Attitude Toward Physics (ATP) has a role that can't be ignored in the development of modern human civilization. This is supported by the fact that physics is a basic science in the development of technology used by humans (Oral & Erkilic, 2022). Several communication technologies such as mobile phones and laptops consist of an important component called a transistor that was developed by physicists. It is undeniable that several of these communication technologies play an important role in the continuity of human activities during the Covid-19 pandemic (Awaludin et al., 2022; Islam & Habib, 2021; Ratih et al., 2021). The importance of physics in the development of technology and the sustainability of human activity confirms that a positive attitude towards physics is an important thing for humans to have,

especially students as future successors of a nation.

Students who have a positive attitude towards physics tend to have perceptions of and interest in physics, physics teachers, and the physics learning climate. Perception and interest in physics are important factors for students to be ready to accept learning (Oral & Erkilic, 2022). The tendency of students' attitudes towards physics can be seen through several indicators. These indicators are enthusiasm for physics (W. K. Adams et al., 2006; Capriconia & Mufit, 2022; Christidou, 2011), quality of learning physics (Juuti & Lavonen, 2016; Tytler, 2014), perception of physics as a process (Christidou, 2011; Walberg, 1976), teaching quality of physics teachers (Astalini, Kurniawan, et al., 2019; Buabeng et al., 2015; Oon & Subramaniam, 2010), and the perception of physics as an upcoming work (Christidou, 2011; Halim et al., 2018). Therefore, students with positive attitudes towards physics tend to process learning with high quality. This is supported by several studies which prove that ATP has a positive correlation with learning outcomes and students' understanding of physics (Astalini, Darmaji, et al., 2019; Kurniawan et al., 2018). In other words, learning needs to be presented in such a way as to make students have ATP that tends to be positive, so that students have an interest in and maximize their potential in processing learning physics learning and can obtain high-quality learning outcomes.

Basically, the factors that affect students' ATP scores can be traced based on the ATP indicators that have been revealed previously. Based on the indicators that have been explained, it can be understood that student ATP is very dependent on the implementation of physics learning in class. Pedagogically, teacher delivery in learning is manifested in the learning models, learning media, and learning approaches used (Santrock, 2018; Wenning & Vieyra, 2020). This is supported by many researchers who conducted research related to ATP with various treatments in the form of learning models (Bedemo, 2020; Maison et al., 2021), learning media (Aşiksoy & Islek, 2017; Oymak & Ogan-Bekiroglu, 2021), and learning approaches (Al-Derbashi, 2017; Kyado et al., 2021). Various kinds of efforts in learning physics are expected to succeed in encouraging students to have a positive attitude toward physics.

The success of the efforts that have been made needs to be measured by a measuring tool called an instrument. Instruments are part of an assessment that can be used to reveal information on learning processes and outcomes (Chappuis & Stiggins, 2019; Hamidah & Wulandari, 2021). This information is valuable for educational practitioners, both teachers, and researchers, to understand the quality of the learning that has been done.

In relation to attitudes toward physics, several researchers have developed various ATP questionnaires that can be used to understand the tendency of students' attitudes toward physics. These questionnaires are named VASS (Halloun & Hestenes, 1998), MPEX (Omasits & Wagner, 2006), CLASS (W. K. Adams et al., 2006), PAS (Kaur & Zhao, 2017), and PCAS (ÇERMİK & KARA, 2020). These five instruments are valid and reliable instruments. However, the instrument that best fits the ATP definitions and indicators that have been described previously is the PAS instrument. Kaur & Zhao developed the Physics Attitude Scale (PAS) by conducting empirical tests on high school students in India. This empiric test produced a questionnaire with 60 questions, where each factor contained 10-14 questions. The questionnaire was presented by applying a 5-point Likert scale, namely "Strongly Agree",

"Agree", "Neutral", "Disagree", and "Strongly Disagree". The results of this development are a valid questionnaire based on experts via CVR and reliable with a Cronbach Alpha value of 0.89 (DeVellis, 2016; Tavakol & Dennick, 2011). Thus, the PAS Questionnaire is feasible and effective tool to measure ATP high school students.

However, the PAS Questionnaire developed by Kaur & Zhao (2017) still has drawbacks when applied to Indonesian students. Kaur & Zhao developed a PAS Questionnaire for students in India, where social life in India is very different from that in Indonesia. Indian society tends to have a more expressive, interruptive, and active communication style than Indonesian society (Gupta & Sukamto, 2020). This shows that Indonesian people tend not to talk much and express their expressions compared to Indian people. Indonesian people tend to be introverted and play it safe in expressing themselves. This is supported by several survey studies using a 5-point Likert scale. Indonesian tend to choose the “neutral” option (Mumu et al., 2022; Solikhah, 2014; Umar et al., 2022). Therefore, using a 5-point Likert scale is not very effective in Indonesia. In addition, Indonesian students tend to have low scientific literacy (Herman et al., 2022; Ishartono et al., 2021; OECD, 2019). Therefore, many assessment items in the questionnaire will make students feel bored and lazy making a serious answer. Thus, adjustments still need to be made if the PAS Questionnaire is applied to high school students in Indonesia.

In summary, the conceptual framework for this research is illustrated in Figure 1. Modifications to the PAS Questionnaire have been done by making changes according to the characteristics of Indonesian students. The change that made is to shorten the number of statement items in the questionnaire. So, students do not feel bored when filling out the questionnaire. In addition, changes made to the provision of scale. The scale used is a 4-point Likert scale with the options "Strongly Agree", "Agree", "Disagree", and "Strongly Disagree". By providing such answer options, the questionnaire can ascertain the tendency of students' answers (Chyung et al., 2017; Croasmun & Ostrom, 2011). Therefore, this study aims to develop a new instrument that solve the shortcomings in PAS Questionnaire and suitable to Indonesian students called Indonesian Modification of PAS (IMPAS) and test its validity and reliability. From the research purpose, the research questions are: (1) how is the development of IMPAS?; (2) what kind of modifications occur in IMPAS?; (3) how are the validity and reliability of IMPAS?; and (4) what is the recommendation for further research?

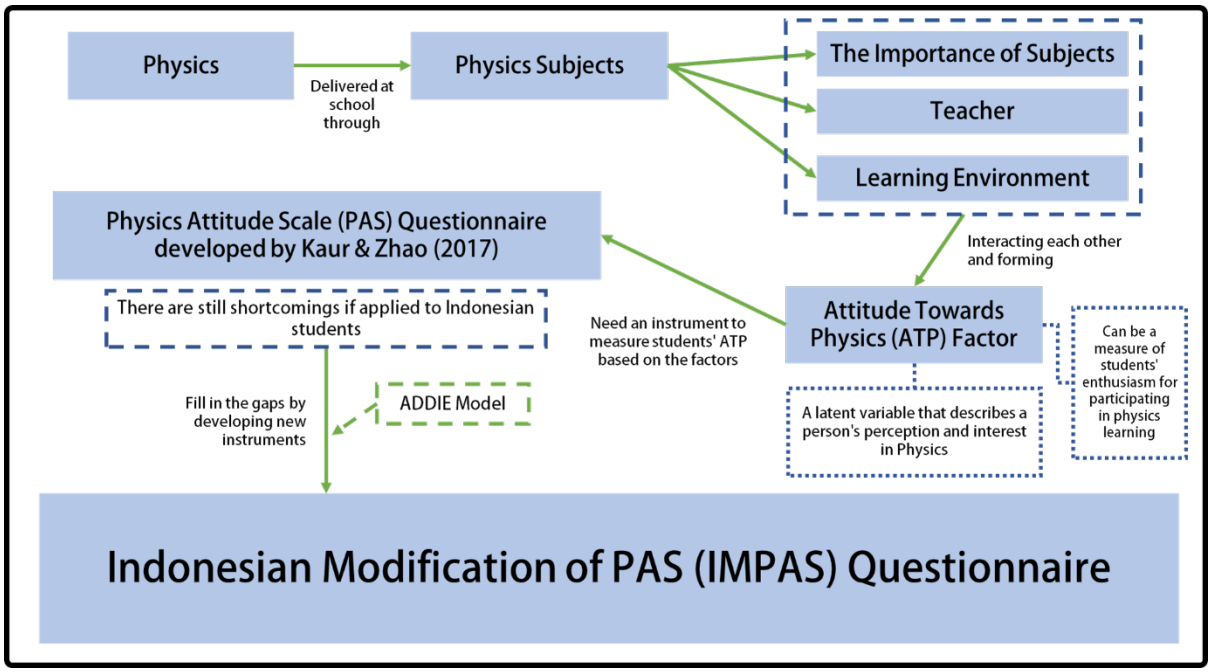

Figure 1. IMPAS Research Conceptual Framework

2. Method

a. Research Design

IMPAS is a modified questionnaire developed from the PAS Questionnaire to measure students' attitudes toward physics in Indonesia. IMPAS was developed using the ADDIE (Analyzing, Designing, Creating, Implementing, Evaluating) model. The applied research design is shown in Figure 2.

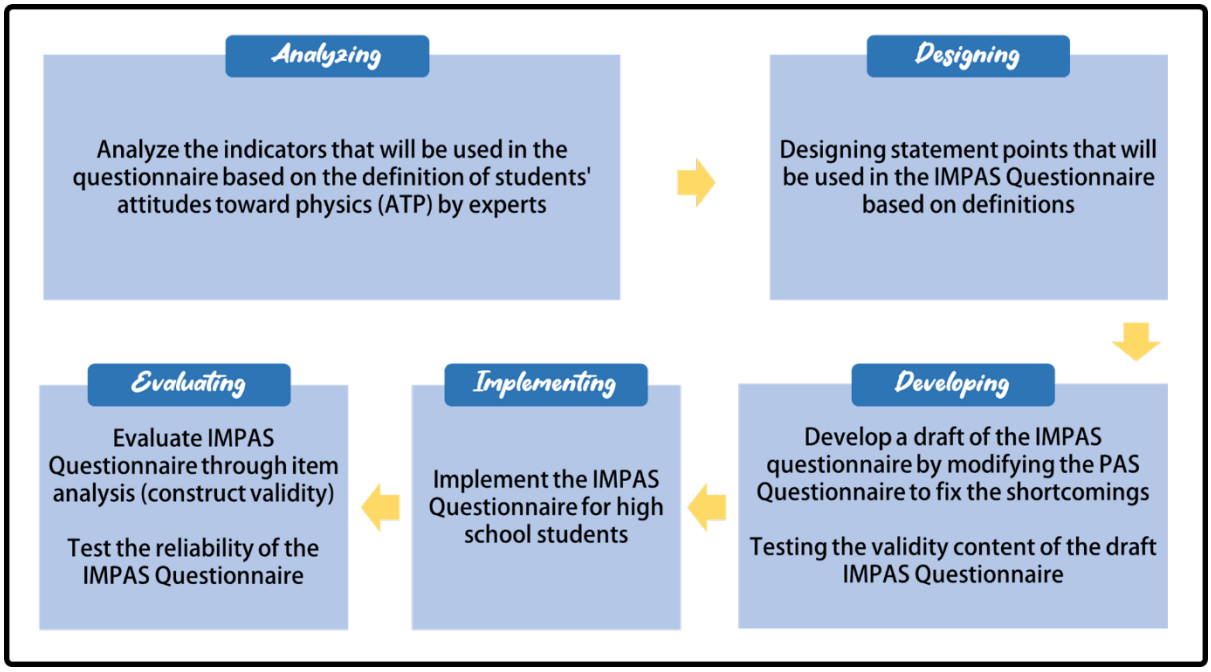

Figure 2. IMPAS' Research and Development Design

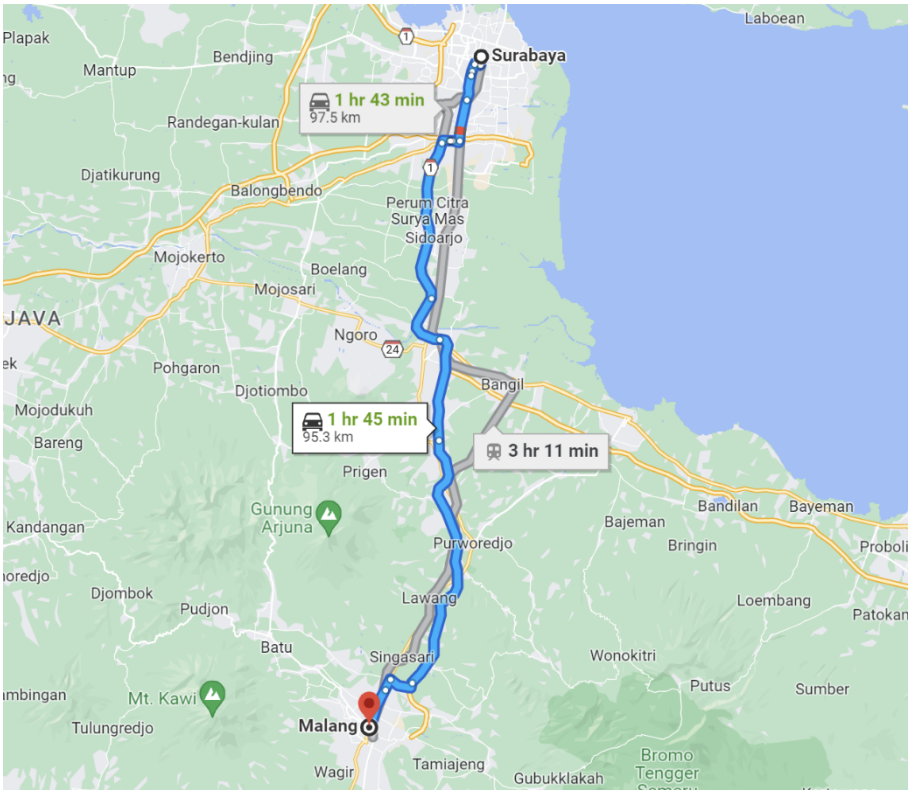

Figure 3. Location Map of Malang City from the Center of the Provincial Capital City

b. Research Participant

This study involved three physics lecturers and two physics teachers to validate the instruments to be developed. This instrument was tested on 156 students aged 15-18 in one of the public high schools in Malang City using a cluster random sampling technique. Malang City located ± 96 km from the center of the East Java capital city, namely Surabaya as shown in Figure 3.

c. Research Instrument

The instruments used in developing the IMPAS Questionnaire were the IMPAS validation questionnaire and the IMPAS trial draft. The IMPAS validation questionnaire contains a question "Are the statements submitted able to reveal students' attitudes toward physics?" addressed to each statement item in the IMPAS draft. There are three answer options for this question, namely "Essential", "Important, but not essential", and "Not important". On the other hand, the pilot draft of the IMPAS Questionnaire consisted of 25 statements regarding attitudes toward students. The IMPAS Questionnaire draft was prepared based on a modification of the PAS Questionnaire developed by Kaur & Zhao (2017). In addition to reducing statement items and changing scale points, the PAS Questionnaire will also be translated into Indonesian so that students can easily understand each statement item. Language is a socio-cultural-based communication tool, so language adaptation can facilitate human understanding in exchanging opinions and thoughts (Asrial et al., 2019; Giyoto et al., 2022; Sirbu, 2015). The IMPAS test draft consists of positive (+), negative (-), neutral positive (0+), and neutral negative (0-) sentences. The IMPAS Questionnaire draft was prepared on a 4-point Likert scale. A questionnaire with a 4-point Likert scale has commonly applied in Indonesia (Ishartono et al., 2022; Mutohhari et al., 2021; Samsudin,

Rusdiana, et al., 2021; Susilowati et al., 2022). Students are expected to be able to understand each statement item because student understanding of the statement items will influence decision-making on the Likert scale presented (Alabi & Jelili, 2022).

d. Research Data Collecting and Analysis

The IMPAS validation questionnaire was addressed to experts, such as three physics lecturers and two physics teachers. After the statement items were developed, the draft IMPAS Questionnaire was tested for content validity by experts to determine the feasibility of each statement item. Data answers from experts were converted into quantitative data based on Lawshe (1975). Content validity is determined by calculating the value of Content Validity Ratios (CVR) from the assessment of experts. The CVR value is calculated based on Lawshe's (1975) equation as in Equation 1.

$$CVR = \frac{n_e - N/2}{N/2}$$

Equation Description:
N = The number of experts judging
n_e = The number of items that esential based on expert judgment

After being tested for content validity, the IMPAS draft was tested empirically on high school students to obtain construct validity, Cronbach Alpha (Internal Consistency), item reliability, and person reliability. Students will fill out a Likert scale IMPAS Questionnaire with 4 options. The scoring weight is carried out based on the type of statement by adapting from Mumu et al. (2022), which is shown in Table 1. Based on Table 1, the results of scoring through the IMPAS Questionnaire make it possible to obtain eight value scales. Therefore, scoring based on Table 1 can produce eight scoring scales for IMPAS. The data from filling out the questionnaire by students will be analyzed by Rasch analysis using Winstep v. 5.4.2.0 to determine construct validity (rating scale and data fit), item reliability, person reliability, and internal consistency. The validity of an instrument can be said constructively from two points of view. Through the rating scale, an instrument is stated as a valid instrument if it has an OBSVD AVRGE score which tends to increase as the label/scale increases and the difference between the ANDRICH THRESHOLD score for each scale is in the value range of 1.4 – 5.0. Through fit data, the MNSQ Infit-Outfit score is in the range of 0.5 – 1.5 and the ZSTD Infit-Oufit score is in the range of -2.00 – 2.00 (Adams et al., 2018; Bond et al., 2020; Boone & Staver, 2020; Khine, 2020; Sumintono & Widhiarso, 2015). The interpretation for internal consistency is adapted from Sumintono & Widhiarso (2014) and Mufida et al. (2022) shown in Table 2. Besides, the interpretation for item reliability and person reliability was adapted from Sumintono & Widhiarso (2015) and Mufida et al. (2022) shown in Table 3.

Table 1. Scoring Guideline on IMPAS

Type of Statement	Score			
	Strongly Disagree	Disagree	Agree	Strongly Agree
+	0	1	6	7
0+	2	3	4	5
0-	5	4	3	2
-	7	6	1	0

Table 2. Interpretation for Internal Consistency

Cronbach Alpha Range	Interpretation
$\alpha \geq 0.8$	Very Good
$0.8 > \alpha \geq 0.7$	Good
$0.7 > \alpha \geq 0.6$	Sufficient
$0.6 > \alpha \geq 0.5$	Bad
$0.5 > \alpha \geq 0.4$	Very Bad

Table 3. Interpretation for Item Reliability and Person Reliability

Value Range	Interpretation
$value \geq 0.95$	Excellent
$0.95 > value \geq 0.91$	Very Good
$0.91 > value \geq 0.81$	Good
$0.81 > value \geq 0.68$	Moderate
$0.68 > value$	Weak

3. Result and Discussion

a. Analyzing

This stage is carried out by analyzing the variables related to students' attitudes toward physics based on experts. Students' attitudes towards subjects at school are closely related to the process of interaction between the importance of subjects, teaching teachers, and the learning environment (Deieso & Fraser, 2019). Students' perceptions of the importance of physics subjects at school make students think that jobs related to physics are important job. So, students will tend to have aspirations in the form of jobs related to physics (Christidou, 2011; Halim et al., 2018). To be able to achieve their goals, students need to be encouraged to bring up the perception that physics is a thought process (Christidou, 2011; Walberg, 1976). This perception must be maintained by teachers who teach in the classroom because teachers are mentors, regulators, and controllers of learning physics in schools (Astalini, Darmaji, et al., 2019; Buabeng et al., 2015; Oon & Subramaniam, 2010). A physics teacher who has good teaching quality means that physics learning in schools also has good quality (Juuti & Lavonen, 2016; Parmin et al., 2021; Tytler, 2014). Learning that reaches students will spur students to be enthusiastic or not in participating in learning. Learning physics with good quality will spur students to have high enthusiasm for learning physics (W. K. Adams et al., 2006; Capriconia & Mufit, 2022; Christidou, 2011). Students' attitudes towards physics can be seen through the enthusiasm of students in participating in physics lessons. Based on research and statements from experts, there will be five factors in determining students' attitudes toward physics. These five indicators have been included in the PAS Questionnaire developed by Kaur & Zhao (2017). The PAS Questionnaire has a structure as shown in Table 4.

Table 4. PAS Questionnaire Structure in measuring ATP (Kaur & Zhao, 2017)

No	ATP Factors	Item Number	Number of Positive Items	Number of Negative Items
1	Enthuasiasm Toward Physics	1-10	8	2
2	Physics Learning	11-24	6	8
3	Physics as a Process	25-35	8	3
4	Physics Teacher	36-49	6	8
5	Physics as a Future Vocation	50-60	4	7
	Number of Items		32	28

Table 5. IMPAS Questionnaire Draft Structure

No	ATP Factors	Code	Number of Items			
			+	0 +	0 -	-
1	Enthuasiasm Toward Physics	AF	2	1	0	2
2	Physics Learning	KP	2	0	2	1
3	Physics as a Process	FP	1	2	0	2
4	Physics Teacher	KG	2	0	2	1
5	Physics as a Future Vocation	MD	1	2	0	2
	Number of Items		8	5	4	8

Based on the analysis conducted on the PAS Questionnaire, the number of items presented in the questionnaire was too much. Indonesian students tend to get bored quickly when there are too many unfamiliar texts (Pratama & Sumardi, 2022; Yuliarsih & Sy, 2022). In addition, applying a 5-point Likert scale is not suitable for Indonesian students because Indonesian students will tend to choose safe answers, namely "Neutral" answers (Mumu et al., 2022; Solikhah, 2014; Umar et al., 2022). Therefore, it is necessary to summarize the questionnaire, to familiarize sentences, and to decrease the choices of answer for the students.

b. Designing

The IMPAS instrument was designed by modifying the PAS Questionnaire that was created by Kaur & Zhao, (2017). Modification steps to overcome some of the shortcomings in the PAS Questionnaire are 1) summary statement items; 2) language switching from English to Indonesian; and 3) changing the Likert scale from 5 points to 4 points. Summarizing the statement items is done by summarizing the 60 statement items into 25 statement items with the same number of ATP factors. Therefore, each ATP factor has the same number of items, namely 5 statement items. In addition, the development of the grain trend level was also carried out. In the PAS Questionnaire, there were only positive and negative sentences, while in the

IMPAS Questionnaire, the positive and negative sentences were developed into positive (+), negative (-), positive neutral (0+), and negative neutral (0-) sentences. Therefore, the weighting of statement items is different based on the type of sentence presented. The types of sentences presented are spread evenly on 25 statement items with 8 positive sentences, 8 negative sentences, and 9 neutral sentences. With reference to Table 1, the maximum score that can be produced by students is 82. The structure of the IMPAS Questionnaire is as Table 5.

The language transfer from English to Indonesian is carried out by referring to the EYD in a standard and effective manner to make it easier for students to understand the statement items in the questionnaire. After each item has been translated, the questionnaire is served with a 4-point Likert scale for each item statement. The options available to students are “Strongly Disagree (STS)”, “Disagree (TS)”, “Agree (S)” and “Strongly Agree (SS)”. This modified questionnaire is called the draft IMPAS Questionnaire.

c. Developing

The content validity test was carried out on the draft IMPAS Questionnaire produced in the previous stage. The content validity test was carried out by experts by answering a question in the IMPAS validation questionnaire. Then, the answers from the experts were processed by calculating the CVR. The results of the CVR calculation reveal that there is 1 statement on the ATP factor with the KG code which is not suitable for use. This is because the CVR results of these questions are below the accepted minimum CVR value, 0.99, at a significance level of 0.05 (Lawshe, 1975). Therefore, the number of statement items used is 24 items with several revisions based on suggestions by experts. The results of the revision of the instrument are arranged in a format as shown in Figure 4.

Items

Aspect	No.	Statement Items	Opinion			
			STS	TS	S	SS
Enthusiasm Toward Physics	1	....				
	2	....				
	3	....				
	4	....				
	5	....				
. . . . .	1	....				
	2	....				
	3	....				
	4	....				
	5	....				

Figure 4. IMPAS Questionnaire Format

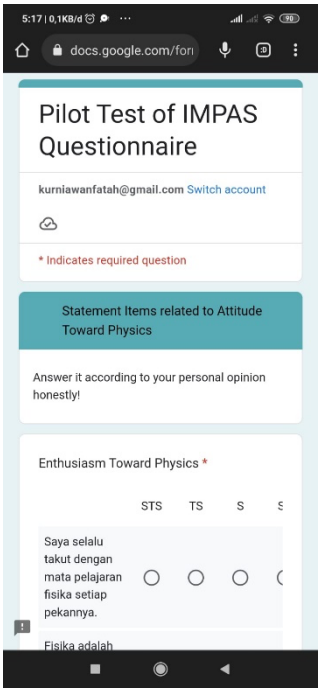

Figure 5. The Display of the Google Form for the IMPAS Questionnaire Trial

The format in Figure 5 is presented in a Google Form as shown in Figure 5. The IMPAS Questionnaire was developed in the form of a Google Form so that students can access it easily.

d. Implementing

After being developed, the IMPAS Questionnaire draft was tested on high school students in Malang City, East Java, Indonesia. Through the Google Form, students can access the IMPAS trial questionnaire as shown in Figure 6. Students are expected to be able to fill out all of the statement items provided in the questionnaire. The questionnaire filling data for each student is then recorded and processed at the Evaluating stage.

e. Evaluating

The evaluation stage is carried out by analyzing the items in the IMPAS Questionnaire statement along with the scoring carried out. After conducting construct validation on the rating scale, the results of the analysis are shown in Table 6.

Based on Table 6, the Observed Average (OBSVD AVRGE) values do not meet the monotonic pattern (Walker & Wind, 2020). This is because the OBSVD AVRGE value of scale 2 appears to decrease from the OBSVD AVRGE value of scale 0 and scale 1 (marked by an asterisk in Table 6). The OBSVD AVRGE scores on a scale of 0 and 1 which are greater than the OBSVD AVRGE scores on a scale of 2 mean that students with high abilities tend to choose scales 0 and 1. Of course, these results are inaccurate because students who have higher abilities tend to answer the higher scale. Thus, an instrument should ideally have a greater OBSRVD AVRGE value as the rating scale is higher (Brann et al., 2021). In addition, it can be seen that the difference in the ANDRICH-THRESHOLD values between scales 3 and 4 is less than outside the ideal difference range. The ideal ANDRICH-THRESHOLD difference between scales is in the range of 1.4 – 5.0 (Linacre, 1999; Sumintono & Widhiarso, 2015). The situation in Table 6 can be visualized in Figure 7.

Figure 6. Students filling out the IMPAS Trial Questionnaire

Table 6. Rating Scale Analysis on 8-scale-scoring IMPAS Questionnaire Draft

Category		OBSVD AVRGE	ANDRICH-THRESHOLD	ANDRICH-THRESHOLD Differences
Label	Score			
0	0	.07	NONE	-
1	1	.12	-2.18	2.18
2	2	-.08*	1.96	4.41
3	3	-.06	-1.42	3.38
4	4	.12	-.42	1
5	5	.26	1.43	1.85
6	6	.49	-1.39	2.82
7	7	.85	2.02	3.41

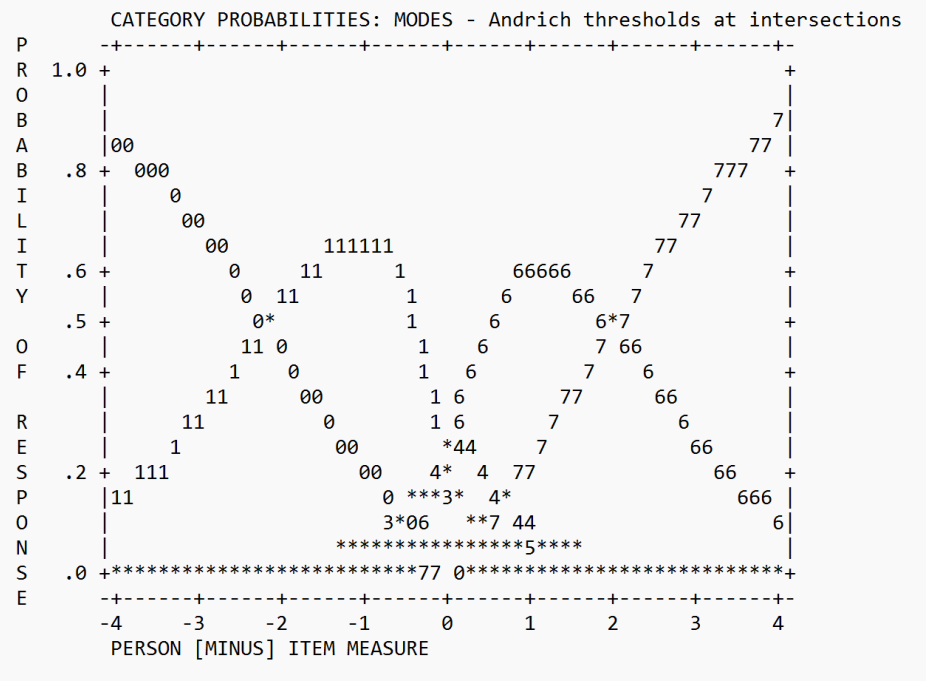

Figure 7. Intersection between the scoring scales on the 8-scale-scoring IMPAS Questionnaire

Figure 7 above shows the curve of each scale that has been selected. The curves where the peaks can be seen to be separated are on a scale of 0, 1, 6, and 7, while on scales 2, 3, 4, and 5 it is difficult to distinguish the peaks. These results indicate that it is difficult for respondents to distinguish between scales with ratings of 2, 3, 4, and 5 (Shi et al., 2019; Tian et al., 2021). Through this description, it can be understood that it is necessary to re-determine the scoring on the IMPAS Questionnaire. So, each scale can truly be understood by respondents. Re-determination regarding scoring for the IMPAS Questionnaire can be carried out in accordance with the rating scale analysis that has been carried out.

Based on the results of the rating scale analysis, re-scoring is carried out as shown in Table 7.

Table 7. Scoring Guideline for IMPAS Revision Edition

Type of Statement	Score			
	Strongly Disagree	Disagree	Agree	Strongly Agree
+	1	2	3	4
0+	2	2	3	3
0-	3	3	2	2
-	4	3	2	1

Table 8. Rating Scale Analysis on 4-scale-scoring IMPAS Questionnaire Draft

Category		OBSVD AVRGE	ANDRICH-THRESHOLD	ANDRICH-THRESHOLD Differences
Label	Score			
1	1	-.42	NONE	-
2	2	-.18	-3.78	3.78
3	3	1.19	-.19	3.58
4	4	2.69	3.97	4.18

Based on Table 7, scoring through IMPAS allows only 4 value scales to be obtained. By using the scoring criteria as in Table 7, a construct validation analysis was obtained in the rating scale section as shown in Table 8. Table 8 shows that the AVRGE OBSVD value on each scale increases frequently with increasing rating scales. This situation fulfills a monotonic pattern (Brann et al., 2021; Walker & Wind, 2020). In addition, each scale has different ANDRICH-THRESHOLD values which fall within the ideal difference range. This situation is also supported visually by Figure 8. Figure 8 shows that each scale curve can be clearly distinguished. This situation further gives confidence that the four scales can be easily distinguished by respondents (Shi et al., 2019; Tian et al., 2021). In other words, respondents were able to distinguish the 4 scales provided in the IMPAS Questionnaire. Therefore, scoring using the 4-scale method is more suitable for assessing the results of the IMPAS Questionnaire.

The suitability of the results of the 4-scale-scoring IMPAS Questionnaire trial with the Rasch model was obtained through analysis of fit data. The results of the fit data analysis are shown in Table 9.

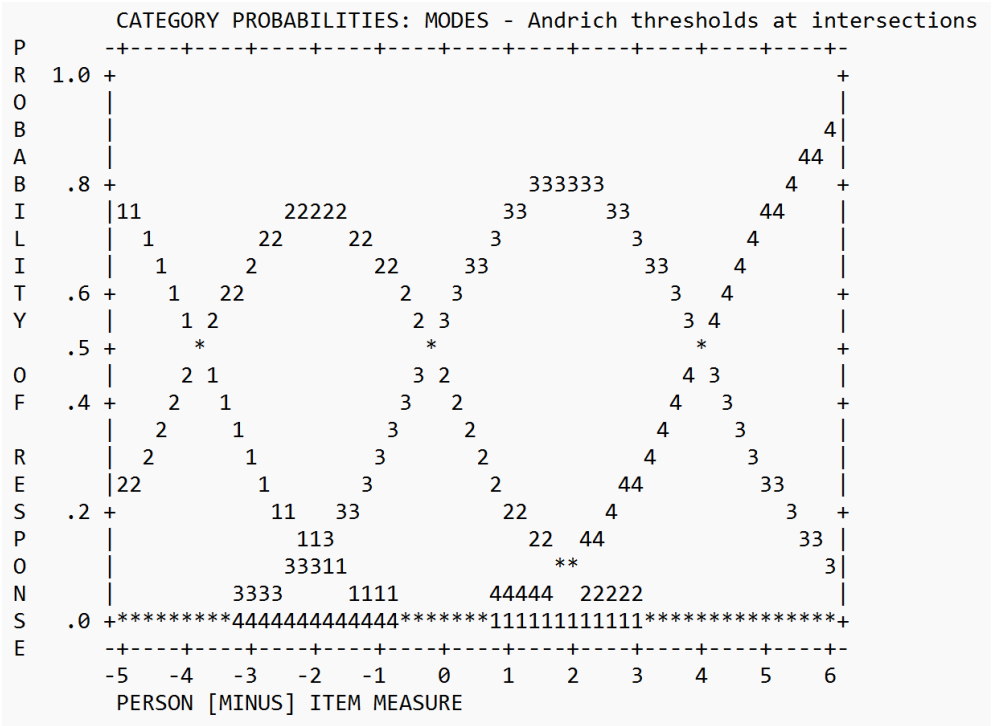

Figure 8. Intersection between the scoring scales on the 4-scale-scoring IMPAS Questionnaire

Table 9. Mean Score Summary from Measured Person and Measured Item

	Infit		Outfit		Separation	Reliability	Cronbach Alpha
	MNSQ	ZSTD	MNSQ	ZSTD			
Person	1.00	.01	.99	-.03	1.72	.75	.77
Item	1.00	-.41	.99	-.45	6.33	.98	

Table 9 shows that the MNSQ Infit-Outfit values of Persons and Items are in the range of 0.50 – 1.50. In addition, the Infit-Outfit ZSTD values of Persons and Items are in the range of -2.00 – 2.00. These results indicate that the MNSQ and ZSTD values that appear are in the acceptable range. Even deeper, the MNSQ score has a value that is very close to 1.00, which is the ideal number for the MNSQ score (Bond et al., 2020; Boone & Staver, 2020; Hermita et al., 2021; Jüttner et al., 2013; Samsudin, Cahyani, et al., 2021). The measurements carried out fit the Rasch Model so that the instrument is valid to be processed using the Rasch model analysis (Sumintono & Widhiarso, 2015). In addition, Table 8 also provides information regarding person reliability, item reliability, and internal consistency. Based on the criteria in Table 2, it can be understood that person reliability is included in the Moderate criteria, while item reliability is included in the Excellent criteria. The relationship between person reliability and item reliability is shown by the Cronbach Alpha value. This value also indicates the level of internal consistency of the IMPAS instrument. Based on Table 3, IMPAS has a Good Level of internal consistency. With these results, the IMPAS Questionnaire is consistent enough to measure students' attitudes toward physics.

4. Conclusion

A modified questionnaire from the PAS Questionnaire has been developed successfully through ADDIE Model. The modified questionnaire is called the Indonesian Modification of PAS (IMPAS) Questionnaire. There are three modifications in the IMPAS Questionnaire, such as 1) summarizing the statement items, 2) translating language from English to Bahasa Indonesia, and 3) changing the Likert scale from 5 points to 4 points. Through CVR analysis and the Rasch model, the IMPAS Questionnaire can be stated as a valid and reliable instrument for measuring students' attitudes toward physics. However, the IMPAS Questionnaire still can be developed further so that IMPAS has a very good quality as an instrument for measuring high school students' attitudes towards physics in Indonesia.

5. Acknowledgment

This research was funded by the Universitas Pendidikan Indonesia Grant Fund.

6. References

Adams, D., Sumintono, B., Mohamed, A., & Noor, N. S. M. (2018). E-learning readiness among students of diverse backgrounds in a leading Malaysian higher education institution. *Malaysian Journal of Learning and Instruction*, *15*(2). https://doi.org/10.32890/mjli2018.15.2.9

Adams, W. K., Perkins, K. K., Podolefsky, N. S., Dubson, M., Finkelstein, N. D., & Wieman, C. E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey. *Physical Review Special*

Topics - Physics Education Research, *2*(1). https://doi.org/10.1103/PhysRevSTPER.2.010101

Alabi, A. T., & Jelili, M. O. (2022). Clarifying likert scale misconceptions for improved application in urban studies. *Quality and Quantity*. https://doi.org/10.1007/s11135-022-01415-8

Al-Derbashi, K. Y. (2017). The Effect of the Flipped Classroom Strategy on Eleventh Grade Students' Understanding of Physics and Their Attitudes Towards Physics in Tonnb Secondary School in the UAE. *Journal of Education and Practice*, *8*(29).

Aşiksoy, G., & Islek, D. (2017). The impact of the virtual laboratory on students' attitudes in a general physics laboratory. *International Journal of Online Engineering*, *13*(4). https://doi.org/10.3991/ijoe.v13i04.6811

Asrial, A., Syahrial, S., Kurniawan, D. A., Subandiyo, M., & Amalina, N. (2019). Exploring obstacles in language learning among prospective primary school teacher. *International Journal of Evaluation and Research in Education*, *8*(2). https://doi.org/10.11591/ijere.v8i2.16700

Astalini, A., Darmaji, D., Pathoni, H., Kurniawan, W., Jufrida, J., Kurniawan, D. A., & Perdan, R. (2019). Motivation and Attitude of Students on Physics Subject in the Middle School in Indonesia. *International Education Studies*, *12*(9). https://doi.org/10.5539/ies.v12n9p15

Astalini, Kurniawan, D. A., Darmaji, Sholihah, L. R., & Perdana, R. (2019). Characteristics of students' attitude to Physics in Muaro Jambi High School. *Humanities and Social Sciences Reviews*, *7*(2). https://doi.org/10.18510/hssr.2019.7210

Awaludin, A., Prayitno, H. J., & Haq, M. I. (2022). Using Digital Media During the COVID-19 Pandemic Era: Good Online Program in Higher Education. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *5*(1). https://doi.org/10.23917/ijolae.v5i1.19574

Bedemo, S. (2020). Effects of Problem Based Learning on Students' Achievement and Attitude Towards Physics (Mechanics): The Case of Gilgel Beles College of Teachers Education. *Science Journal of Education*, *8*(3). https://doi.org/10.11648/j.sjedu.20200803.12

Bond, T. G., Yan, Z., & Heene, M. (2020). Applying the rasch model: Fundamental measurement in the human sciences. In *Applying the Rasch Model: Fundamental Measurement in the Human Sciences*. https://doi.org/10.4324/9780429030499

Boone, W. J., & Staver, J. R. (2020). Correction to: Advances in Rasch Analyses in the Human Sciences. In *Advances in Rasch Analyses in the Human Sciences*. https://doi.org/10.1007/978-3-030-43420-5_21

Brann, K. L., Boone, W. J., Splett, J. W., Clemons, C., & Bidwell, S. L. (2021). Development of the School Mental Health Self-Efficacy Teacher Survey Using Rasch Analysis. *Journal of Psychoeducational Assessment*, *39*(2). https://doi.org/10.1177/0734282920947504

Buabeng, I., Conner, L., & Winter, D. (2015). The Lack of Physics Teachers: "Like a Bath with the Plug out and the Tap half on." *American Journal of Educational Research*, *3*(6). https://doi.org/10.12691/education-3-6-9

Capriconia, J., & Mufit, F. (2022). Analysis of Concept Understanding and Students' Attitudes towards Learning Physics in Material of Straight Motion. *Jurnal Penelitian Pendidikan IPA*, *8*(3). https://doi.org/10.29303/jppipa.v8i3.1381

ÇERMİK, H., & KARA, İ. (2020). Physics Course Attitudes Scale for High School Students: A Validity and Reliability Study. *International Journal of Assessment Tools in Education*. https://doi.org/10.21449/ijate.693211

Chappuis, J., & Stiggins, R. J. (2019). Classroom Assessment for Student Learning: Pearson New International Edition: Doing It Right - Using It Well. In *Assessment*.

Christidou, V. (2011). Interest, attitudes and images related to science: Combining students' voices with the voices of school Science, teachers, and popular science. *International Journal of Environmental and Science Education*, *6*(2).

Chyung, S. Y. Y., Roberts, K., Swanson, I., & Hankinson, A. (2017). Evidence-Based Survey Design: The Use of a Midpoint on the Likert Scale. *Performance Improvement*, *56*(10). https://doi.org/10.1002/pfi.21727

Croasmun, J. T., & Ostrom, L. (2011). Using Likert-Type Scales in the Social Sciences. *Journal of Adult Education*, *40*(1).

Deieso, D., & Fraser, B. J. (2019). Learning environment, attitudes and anxiety across the transition from primary to secondary school mathematics. *Learning Environments Research*, *22*(1). https://doi.org/10.1007/s10984-018-9261-5

DeVellis, R. F. (2016). Scale Development Theory and Applications (Fourth Edition). *SAGE Publication*, *4*.

Giyoto, G., Prayitno, H. J., Inderasari, E., Santoso, T., Salam, A. A. N., & Alfisyahri, K. A. N. (2022). A Lessons in Pandemic Autonomous Learning Conflicts of Communicative Methods in English Curriculum 2013 along COVID-19 in Indonesia. *Randwick International of Education and Linguistics Science Journal*, *3*(4). https://doi.org/10.47175/rielsj.v3i4.578

Gupta, M., & Sukamto, K. (2020). Cultural Communicative Styles: The Case of India and Indonesia. *International Journal of Society, Culture & Language*, *8*(2), 105–120. https://www.ijscl.net/article_39000.html

Halim, L., Abd Rahman, N., Zamri, R., & Mohtar, L. (2018). The roles of parents in cultivating children's interest towards science learning and careers. *Kasetsart Journal of Social Sciences*, *39*(2), 190–196. https://doi.org/https://doi.org/10.1016/j.kjss.2017.05.001

Halloun, I., & Hestenes, D. (1998). Interpreting VASS dimensions and profiles for physics students. *Science and Education*, *7*(6). https://doi.org/10.1023/A:1008645410992

Hamidah, M. H., & Wulandari, S. S. (2021). PENGEMBANGAN INSTRUMEN PENILAIAN BERBASIS HOTS MENGGUNAKAN APLIKASI "QUIZIZZ." *Efisiensi : Kajian Ilmu Administrasi*, *18*(1). https://doi.org/10.21831/efisiensi.v18i1.36997

Herman, Shara, A. M., Silalahi, T. F., Sherly, & Julyanthry. (2022). Teachers' Attitude towards Minimum Competency Assessment at Sultan Agung Senior High School in Pematangsiantar, Indonesia. *Journal of Curriculum and Teaching*, *11*(1). https://doi.org/10.5430/jct.v11n2p1

Hermita, N., Putra, Z. H., Alim, J. A., Wijaya, T. T., Anggoro, S., & Diniya, D. (2021).

Elementary Teachers' Perceptions on Genially Learning Media Using Item Response Theory (IRT). *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *4*(1). https://doi.org/10.23917/ijolae.v4i1.14757

Ishartono, N., Desstya, A., Prayitno, H. J., & Sidiq, Y. (2021). The Quality of HOTS-Based Science Questions Developed by Indonesian Elementary School Teachers. *Journal of Education Technology*, *5*(2). https://doi.org/10.23887/jet.v5i2.33813

Ishartono, N., Nurcahyo, A., Waluyo, M., Prayitno, H. J., & Hanifah, M. (2022). Integrating GeoGebra into the flipped learning approach to improve students' self-regulated learning during the covid-19 pandemic. *Journal on Mathematics Education*, *13*(1). https://doi.org/10.22342/jme.v13i1.pp69-86

Islam, Md. T., & Habib, T. I. (2021). Barriers of Adopting Online Learning Among the University Students in Bangladesh During Covid-19. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *4*(1). https://doi.org/10.23917/ijolae.v4i1.15215

Jüttner, M., Boone, W., Park, S., & Neuhaus, B. J. (2013). Development and use of a test instrument to measure biology teachers' content knowledge (CK) and pedagogical content knowledge (PCK). *Educational Assessment, Evaluation and Accountability*, *25*(1). https://doi.org/10.1007/s11092-013-9157-y

Juuti, K., & Lavonen, J. (2016). How teaching practices are connected to student intention to enrol in upper secondary school physics courses. *Research in Science and Technological Education*, *34*(2). https://doi.org/10.1080/02635143.2015.1124848

Kaur, D., & Zhao, Y. (2017). Development of Physics Attitude Scale (PAS): An Instrument to Measure Students' Attitudes Toward Physics. *Asia-Pacific Education Researcher*, *26*(5). https://doi.org/10.1007/s40299-017-0349-y

Khine, M. S. (2020). Rasch measurement: Applications in quantitative educational research. In *Rasch Measurement: Applications in Quantitative Educational Research*. https://doi.org/10.1007/978-981-15-1800-3

Kurniawan, D. A., Perdana, R., & Kurniasari, D. (2018). Identification of student attitudes toward physics learning at Batanghari District high school. *The Educational Review, USA*, *2*(9), 475–484.

Kyado, J., Achor, E. E., & Gbadamosi, O. (2021). Effect of Brain-Based Learning Strategy on Students' Attitude Towards Physics in Jalingo, Taraba State, Nigeria. *BSU Journal of Science …*.

LAWSHE, C. H. (1975). A QUANTITATIVE APPROACH TO CONTENT VALIDITY. *Personnel Psychology*, *28*(4). https://doi.org/10.1111/j.1744-6570.1975.tb01393.x

Linacre, J. M. (1999). Investigating rating scale category utility. *Journal of Outcome Measurement*, *3*(2).

Maison, Tant, T., Kurniawan, D. A., Sukarni, W., Erika, & Hoyi, R. (2021). Assessing students' attitudes towards physics through the application of inquiry and jigsaw cooperative learning models in high schools. *International Journal of Instruction*, *14*(4). https://doi.org/10.29333/iji.2021.14426a

Mufida, S. N., Kaniawati, I., Samsudin, A., & Suhendi, E. (2022). Developing MOFI on Transverse Wave to Explore Students'

Misconceptions Today: Utilizing Rasch Model Analysis. *Jurnal Penelitian Pendidikan IP*, *8*(5), 2499–2507.

Mumu, J., Tanujaya, B., Charitas, R., & Prahmana, I. (2022). Likert Scale in Social Sciences Research: Problems and Difficulties. *FWU Journal of Social Sciences*, *16*(4). https://doi.org/10.51709/19951272/Winter2022/7

Mutohhari, F., Sutiman, S., Nurtanto, M., Kholifah, N., & Samsudin, A. (2021). Difficulties in implementing 21st century skills competence in vocational education learning. *International Journal of Evaluation and Research in Education*, *10*(4). https://doi.org/10.11591/ijere.v10i4.22028

OECD. (2019). OECD Multilingual Summaries PISA 2018 Results (Volume I) What Students Know and Can Do. *OECD Publishing*, *I*(Volume I).

Omasits, C. J., & Wagner, D. J. (2006). Investigating the validity of the MPEX survey. *AIP Conference Proceedings*, *818*. https://doi.org/10.1063/1.2177044

Oon, P. T., & Subramaniam, R. (2010). Views of physics teachers on how to address the declining enrolment in physics at the university level. *Research in Science and Technological Education*, *28*(3). https://doi.org/10.1080/02635143.2010.501749

Oral, I., & Erkilic, M. (2022). Investigating the 21st -Century Skills of Undergraduate Students: Physics Success, Attitude, and Perception. *Journal of Turkish Science Education*, *19*(1). https://doi.org/10.36681/tused.2022.112

Oymak, O., & Ogan-Bekiroglu, F. (2021). Comparison of students' learning and attitudes in physical versus virtual manipulatives using inquiry-based instruction. *IAFOR Journal of Education*, *9*(4). https://doi.org/10.22492/ije.9.4.02

Parmin, P., Diah Pamelasari, S., & Rahayu, S. (2021). The Effect of Scientific Terms Error on Scientific Communication of Prospective Teachers and Progressive Education. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *3*(3). https://doi.org/10.23917/ijolae.v3i3.14214

Pratama, A., & Sumardi, M. S. (2022). Contextual Teaching and Learning Using Local Content Material on Students' Reading Comprehension at a Junior High School in Indonesia. *SALEE: Study of Applied Linguistics and English Education*, *3*(2). https://doi.org/10.35961/salee.v3i2.494

Ratih, K., Syah, M. F. J., Nurhidayat, N., Jarin, S., & Buckworth, J. (2021). Learning Patterns during the Disruptive Situation in Informal Education: Parents' Efforts and Challenges in the Adjustment of Progressive Learning. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *3*(3). https://doi.org/10.23917/ijolae.v3i3.15151

Samsudin, A., Cahyani, P. B., Purwanto, Rusdiana, D., Efendi, R., Aminudin, A. H., & Coştu, B. (2021). Development of a multitier open-ended work and energy instrument (MOWEI) using Rasch analysis to identify students' misconceptions. *Cypriot Journal of Educational Sciences*, *16*(1). https://doi.org/10.18844/cjes.v16i1.5504

Samsudin, A., Rusdiana, D., Efendi, R., Fratiwi, N. J., Aminudin, A. H., & Adimayuda, R. (2021). Development of Predict-Observe-Explain (POE) Strategy Assisted by Rebuttal Texts on Newton's Law Material with Rasch Analysis. *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, *6*(1).

https://doi.org/10.24042/tadris.v6i1.7641

Santrock, J. W. (2018). Educational psychology, 6th ed. In *McGraw-Hill Education*.

Shi, Y., Gugiu, P. C., Crowe, R. P., & Way, D. P. (2019). A Rasch Analysis Validation of the Maslach Burnout Inventory–Student Survey with Preclinical Medical Students. *Teaching and Learning in Medicine*, *31*(2). https://doi.org/10.1080/10401334.2018.1523010

Sirbu, A. (2015). Language As a Tool of Communication. *ResearchGate*, *18*(2).

Solikhah, B. (2014). An Application of Theory of Planned Behavior towards CPA Career in Indonesia. *Procedia - Social and Behavioral Sciences*, *164*. https://doi.org/10.1016/j.sbspro.2014.11.094

Sumintono, B., & Widhiarso, W. (2014). *Aplikasi model Rasch untuk penelitian ilmu-ilmu sosial (edisi revisi)*. Trim Komunikata Publishing House. http://eprints.um.edu.my/id/eprint/11413

Sumintono, B., & Widhiarso, W. (2015). *Aplikasi pemodelan Rasch pada assessment pendidikan*. Trim Komunikata. http://eprints.um.edu.my/id/eprint/14228

Susilowati, N. E., Muslim, M., Efendi, R., & Samsudin, A. (2022). Pisa 2021 Creative Thinking Instrument for Students: Physics Teachers' Perceptions. *Indonesian Journal of Science and Mathematics Education*, *5*(2). https://doi.org/10.24042/ijsme.v5i2.12439

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. In *International journal of medical education* (Vol. 2). https://doi.org/10.5116/ijme.4dfb.8dfd

Tian, Y., Wang, L., Xu, Y., & He, Z. (2021). The Development of Chinese Version of Transcultural Nursing Self-Efficiency Scale: Using Rasch Model Analysis. *Journal of Transcultural Nursing*, *32*(1). https://doi.org/10.1177/1043659619896827

Tytler, R. (2014). Attitudes, identity, and aspirations toward science. In *Handbook of Research on Science Education, Volume II*. https://doi.org/10.4324/9780203097267.ch5

Umar, N. F., Sinring, A., Pandang, A., & Anas, M. (2022). Career Self-Management Scale (CEDLE scale) in the Indonesian Version of The Social Cognitive Model. *INDONESIAN JOURNAL OF EDUCATIONAL STUDIES (IJES)*, *25*(1), 10–20.

Walberg, H. J. (1976). 4: Psychology of Learning Environments: Behavioral, Structural, or Perceptual? *Review of Research in Education*, *4*(1). https://doi.org/10.3102/0091732X004001142

Walker, A. A., & Wind, S. A. (2020). Identifying Misfitting Achievement Estimates in Performance Assessments: An Illustration Using Rasch and Mokken Scale Analyses. *International Journal of Testing*, *20*(3). https://doi.org/10.1080/15305058.2019.1673758

Wenning, C. J., & Vieyra, R. E. (2020). Teaching High School Physics: Interacting with Physics Students. In *AAPT Physics Education*.

Yuliarsih, Y., & Sy, E. N. S. (2022). The Effect of E-Learning as Media in Teaching Reading: Quasi-Experimental Design at Wachid Hasyim Senior High School Pamekasan Regency, Indonesia. *International Journal of Multicultural and Multireligious Understanding*, *9*(9), 224–230.