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Innovation Learning on The Topic of Sound: Rasch Analysis on Team Game Tournament with Uno Card Media

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Abstract

This study aims to analyze the characteristics of the Teams Game Tournament (TGT) learning model instrument using the Rasch model on the topic of sound, incorporating Bloom's cognitive features. The analysis focuses on validity, reliability, discrimination capacity, and difficulty level to determine the instrument's feasibility. The study adopts the classroom action research paradigm. The instrument comprises ten multiple-choice questions. The findings indicate that the instrument demonstrates adequate validity within an acceptable range. The reliability analysis yields a Cronbach's alpha score of 0.82, indicating high reliability, with item reliability at 0.36 and person reliability at 0.32. Additionally, the discriminating power meets the criteria, as shown by Infit Mean Square (MNSQ), Outfit Z-Standard (ZSTD), and Point Measure Correlation (PT Measure Corr). Regarding difficulty level, the instrument includes five questions categorized as difficult, three as moderate, and two as easy.

Keywords: Teams Game Tournament (TGT), Rasch model, learning outcomes

INTRODUCTION

The best education in today's culture requires research from educational institutions. People no longer view education as a luxury. How well instructors manage teaching and learning activities significantly influences the quality of education. There has been interaction between teachers and students in the teaching and learning activities that take place (Djamarah et al. 2006). A teacher must be able to create a valuable environment for education if they want their students to learn.

Education means the power of effort to encourage the growth of ethics (inner strength and character), the mind, and the development and growth of children (Hamzah et al. 2016). To aid in the development of individuals through their learning, education also involves modifying one's attitude and behavior. The educational process shapes learners' attitudes, enhances their intelligence, and develops their abilities to align with the direction and purpose of education. Every government should invest heavily in education, but developing countries like Indonesia that are actively creating their own countries need to do even more. Growth can benefit from advances in science and technology.

The term "physics" meaning nature, is the study of nature. Physics is the study of natural phenomena and qualities. Analytical and empirical evidence can be used to support the existence of natural phenomena. To succeed in a high school physics course, students must have conceptual knowledge of

physics and the capacity to apply it to new findings. Until recently, the majority of students mainly thought about learning physics formulas, which led them to describe physics in a specific way such as numerically. Although explanations can also be presented verbally, verbal descriptions of basic meanings and concepts can be used to describe physical phenomena. Since it is sometimes difficult to visualize physical events, Figures are also used to describe physical phenomena.

Based on a preliminary study conducted at one of the high schools in Yogyakarta, it is mentioned that students feel bored in learning physics subjects at school. This was reinforced by an interview with one of the teachers who explained that the learning process in class only applied the conventional method of lecture.

Under the educational method known as cooperative learning, students work together to finish homework and handle projects. Apart from enhancing their problem-solving ability, this approach helps them to develop their social skills (Stokes 2024). Through cooperation, they learn from one another and foster teamwork—qualities that would be quite helpful in the classroom and in daily life. Encouragement of student involvement (Chen et al. 2022), shared responsibility (Cecchini et al. 2021), and support of one another has been shown to help learning outcomes in a range of educational settings. Cooperative learning's ability to improve group dynamics, problem-solving ability, and linguistic competency points to its effectiveness (Møgelvang 2024).

Combining aspects of cooperative learning and competitive games, the Teams Games Tournament (TGT) is an instructional tool meant to improve student involvement and learning results. Demonstrating its adaptability and efficacy, this method has been used in reading comprehension (Anggiasari et al. 2018), mathematics (Siregar et al. 2024), physical education (Luo et al. 2020), and others. Under the TGT model, students participate in academic games in teams, therefore promoting group cooperation as well as individual responsibility. In the context of physics material, especially on the topic of sound, the TGT model can increase student engagement and understanding through interactive activities. With the help of Uno card media, learning activities can be packaged in a fun game format, making students more enthusiastic.

The cooperative learning teaching approach aims to increase student engagement, social skills development, and cognitive and attitudinal development. Cooperative learning is instruction that allows students to perform academic tasks in groups (Aliffah, et al. 2013). The supported model is an example of the Teams Games Tournament (TGT) cooperative learning paradigm. These techniques can increase everyone's involvement in the classroom and make learning interesting and fun for students (Fajri, et al. 2012). Learning in the classroom will feel more interesting and fun in this way.

Cooperative learning is a method in which students learn to work together in small groups to achieve a common goal, help each other understand concepts, and improve social skills (Johnson & Johnson 2009). TGT combines elements of games and competition between teams to create a dynamic learning atmosphere (Slavin 1995). Several studies have demonstrated the effectiveness of TGT in various learning contexts, including natural science.

In sound, the use of TGT allows students to explore basic concepts such as frequency, amplitude, and sound wave characteristics more actively. The application of TGT can help students understand difficult concepts through team discussion and competition, where each student contributes to solving the problems and challenges given in the game (Tarim 2009).

Although cooperative learning models, such as Teams Game Tournament (TGT), have been widely applied to improve student participation and understanding, research on the effectiveness of TGT combined with game-based learning media, such as UNO cards, in the context of teaching sound is limited. Previous research has focused more on the cognitive aspects of cooperative learning without integrating game elements that can increase students' emotional and social engagement in the learning process.

The novelty in this study lies in evaluating the quality of the UNO card-based TGT instrument through the Rasch Model approach, which allows in-depth analysis of the fit of items and student responses on a linear scale. This analysis not only quantitatively tests the reliability and validity of the instrument, but also offers insights into how game media such as UNO cards can optimize the learning process of topic of sounds. Thus, this study fills the gap regarding the effectiveness of the combination of TGT method and game media in science learning, and provides an empirical basis for teachers to implement innovative methods that improve students' understanding of sound concepts.

Many studies have shown that the TGT learning model can improve student learning outcomes. For example, Ardilla Ayu Febrina in her thesis in 2016 showed that the use of the TGT learning model with digital games can improve student learning outcomes on the concept of optical devices. The results showed that students who learned with this model showed a significant increase in mastery of the material compared to the traditional method.

Uno card media provides an interesting variation to be applied in TGT due to its ease of use and simplicity of game rules that are familiar to students. Modifying Uno cards by adding symbols or questions related to topic of sound allows students to practice and understand concepts interactively. For example, cards with certain colors or symbols can be customized to symbolize the frequency or amplitude of sound, so that students can associate aspects of sound with the game elements they see. Research by Rani (2019) showed that game media such as Uno cards can increase student engagement in the classroom, as these games bring an element of fun novelty. When integrated with TGT, Uno cards can facilitate group discussions and strengthen students' understanding of topic of sound.

METHOD

This study utilized a classroom action research design. A total of 36 students in class XI were the study subjects for the academic year 2022-2023, with 10 multiple choice questions used to measure student learning outcomes. The objectives of this study were: (1) a Teams Games Tournament (TGT)-based cooperative learning model, utilizing the UNO card game and Physics LKPD as additional resources; (2) student learning activities; (3) student responses; and (4) student learning outcomes. The UNO card used in the competition has the following design.

The development of ten multiple-choice questions that are aligned with the cognitive features in Bloom's Taxonomy requires systematic planning to achieve various levels of students' cognitive understanding, ranging from simple to more complex. the steps taken in the process of developing, designing, and validating the content of the multiple-choice questions include: 1. designing questions based on Bloom's Taxonomy; 2. writing question items; 3. content validity through expert review; 4. question testing; and 5. final revision and development of scoring guide.

Multiple-choice tests, observation sheets, and questionnaires were all used in this study to collect information on students' learning outcomes, activities, and answers. The collected data were then examined using quantitative analysis. This Teams Game Tournament (TGT) instrument stands out because it applies Rasch model analysis to materials that, according to Bloom's latest classification, include cognitive components. The characteristics in this study validity, reliability, item measure, person measure, difficulty level, and Cronbach Alpha (KR-20) are what this study aims to prove. Statistical Analysis of Item and Respondent Fit using Infit Mean Square (MNSQ) and Outfit Mean Square (MNSQ) was used to assess whether any deviations of the data from the model were significant. Ideal MNSQ values range from 0.5 to 1.5. An infit value close to 1 indicates the item has a good fit to the model. ZSTD indicates how far the deviation from the model is in the form of a z-score. The ideal value for ZSTD is between -2 to +2, which indicates that the item has no significant difference from the model.

FIGURE 1. UNO Card Design

RESULTS AND DISCUSSION

Validity

Research using Rasch model analysis with empirical validity. At this level of validity, the goal is to assess whether the designed instrument can capture what needs to be captured and determine the capacity of items to capture the various abilities and perceptions of respondents. FIGURE 2 shows the results of the validity value.

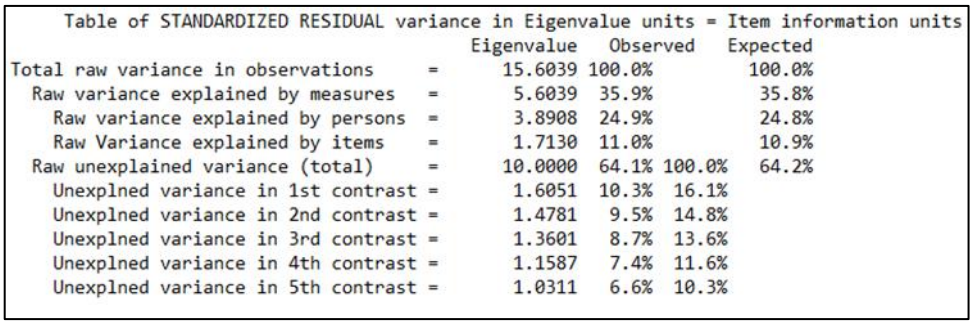


Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = Item information units

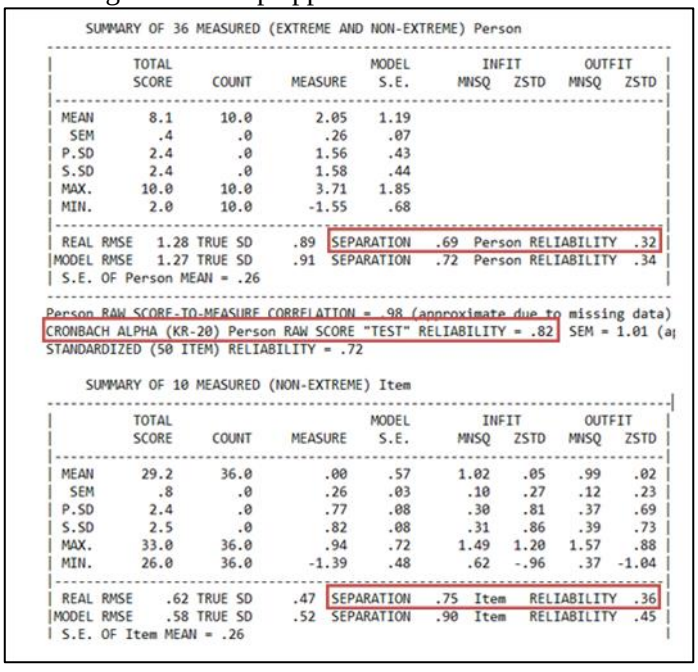
	Eigenvalue	Observed		Expected
Total raw variance in observations =	15.6039	100.0%		100.0%
Raw variance explained by measures =	5.6039	35.9%		35.8%
Raw variance explained by persons =	3.8908	24.9%		24.8%
Raw Variance explained by items =	1.7130	11.0%		10.9%
Raw unexplained variance (total) =	10.0000	64.1%	100.0%	64.2%
Unexplned variance in 1st contrast =	1.6051	10.3%	16.1%	
Unexplned variance in 2nd contrast =	1.4781	9.5%	14.8%	
Unexplned variance in 3rd contrast =	1.3601	8.7%	13.6%	
Unexplned variance in 4th contrast =	1.1587	7.4%	11.6%	
Unexplned variance in 5th contrast =	1.0311	6.6%	10.3%	

FIGURE 2. Validity Value Results

The number 10 in the raw unexplained variance (total) indicates that there are a total of 10 items in the analysis. The raw variance with the measure has a value of 35.9%, which indicates satisfactory validity. The empirical unexplained variance in the first and second contrast values are 10.3% and 9.5% respectively, where these two values indicate shaky validity, following. Thereafter, the unexplained variance of the eigenvalues in the first and second contrasts were 1.6 and 1.4, respectively, and these two values indicate a good model. The test instrument remains ineffective in assessing students' conceptual competence as the validity values on the three criteria show that there is one poor criterion and two acceptable criteria.

Reliability

The Cronbach Alpha (KR-20) rating can be used to determine the overall reliability of the test instrument. The reliability value can be seen from two angles, namely item reliability and respondent reliability (person reliability), in addition to Cronbach's alpha value. The value of the test instrument dependability assessment using the ministep application is shown in the table below.



SUMMARY OF 36 MEASURED (EXTREME AND NON-EXTREME) Person

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	8.1	10.0	2.05	1.19				
SEM	.4	.0	.26	.07				
P.SD	2.4	.0	1.56	.43				
S.SD	2.4	.0	1.58	.44				
MAX.	10.0	10.0	3.71	1.85				
MIN.	2.0	10.0	-1.55	.68				

REAL RMSE 1.28 TRUE SD .89 SEPARATION .69 Person RELIABILITY .32
MODEL RMSE 1.27 TRUE SD .91 SEPARATION .72 Person RELIABILITY .34
S.E. OF Person MEAN = .26

Person RAW SCORE-TO-MEASURE CORRELATION = .98 (approximate due to missing data)
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .82 SEM = 1.01 (a
STANDARDIZED (50 ITEM) RELIABILITY = .72

SUMMARY OF 10 MEASURED (NON-EXTREME) Item

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	29.2	36.0	.00	.57	1.02	.05	.99	.02
SEM	.8	.0	.26	.03	.10	.27	.12	.23
P.SD	2.4	.0	.77	.08	.30	.81	.37	.69
S.SD	2.5	.0	.82	.08	.31	.86	.39	.73
MAX.	33.0	36.0	.94	.72	1.49	1.20	1.57	.88
MIN.	26.0	36.0	-1.39	.48	.62	-.96	.37	-1.04

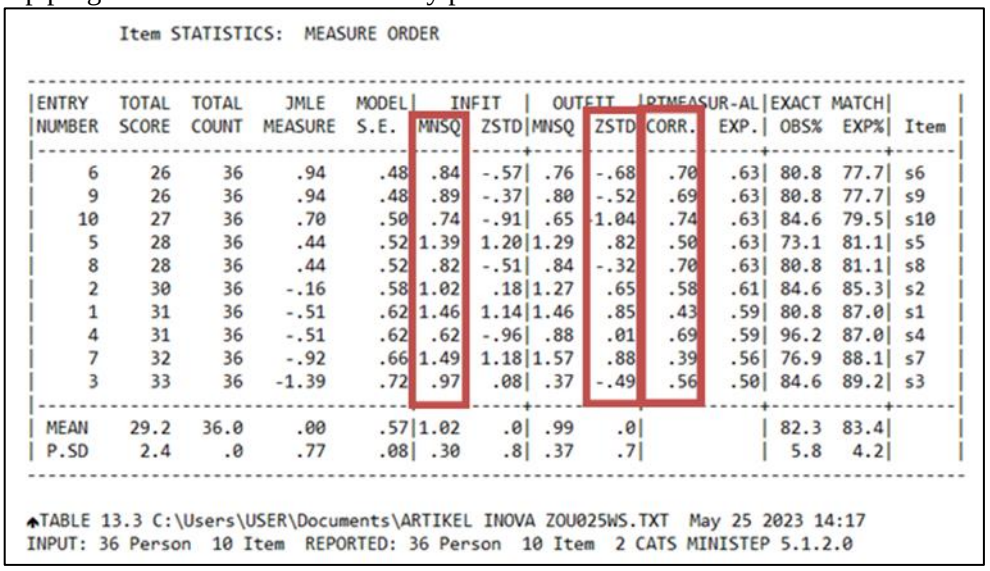
REAL RMSE .62 TRUE SD .47 SEPARATION .75 Item RELIABILITY .36
MODEL RMSE .58 TRUE SD .52 SEPARATION .90 Item RELIABILITY .45
S.E. OF Item MEAN = .26

FIGURE 3. Reliability Results

Based on the findings of the reliability measurement values of the ministep application test instrument, it was determined that the Cronbach alpha logit value (KR-20) is the best way to assess the overall dependability of the test instrument. The instrument was created to have a very high reliability coefficient value, as indicated by the Cronbach alpha achieved at 0.82 in the 'high' category. In addition, the findings of the reliability analysis on items and subjects fall into the "weak" category, indicating that the quality of the question items and the consistency of the students' responses are still below standard.

Distinguishing Power

Point Measure Correlation (PTMEA CORR) indicates the ability of items to discriminate. Items with a point measure correlation above 0.40 have strong discriminating power. In addition, for items with values below 0.40, the values are classified according to Alagumalai, Curtis, and Hungi's (2005) categorization of Point Measure Correlation (PTMEA CORR) values. The mismatch ordering table in the ministep program shows its discriminatory power values.



Item STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	JMLE MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
6	26	36	.94	.48	.84	-.57	.76	-.68	.70	.63	80.8	77.7	s6
9	26	36	.94	.48	.89	-.37	.80	-.52	.69	.63	80.8	77.7	s9
10	27	36	.70	.50	.74	-.91	.65	-1.04	.74	.63	84.6	79.5	s10
5	28	36	.44	.52	1.39	1.20	1.29	.82	.50	.63	73.1	81.1	s5
8	28	36	.44	.52	.82	-.51	.84	-.32	.70	.63	80.8	81.1	s8
2	30	36	-.16	.58	1.02	.18	1.27	.65	.58	.61	84.6	85.3	s2
1	31	36	-.51	.62	1.46	1.14	1.46	.85	.43	.59	80.8	87.0	s1
4	31	36	-.51	.62	.62	-.96	.88	.01	.69	.59	96.2	87.0	s4
7	32	36	-.92	.66	1.49	1.18	1.57	.88	.39	.56	76.9	88.1	s7
3	33	36	-1.39	.72	.97	.08	.37	-.49	.56	.50	84.6	89.2	s3
MEAN	29.2	36.0	.00	.57	1.02	.0	.99	.0			82.3	83.4	
P.SD	2.4	.0	.77	.08	.30	.8	.37	.7			5.8	4.2	

TABLE 13.3 C:\Users\USER\Documents\ARTIKEL INOVA ZOU025WS.TXT May 25 2023 14:17
INPUT: 36 Person 10 Item REPORTED: 36 Person 10 Item 2 CATS MINISTEP 5.1.2.0

FIGURE 4. Differentiating power

From all items all instruments can be used because they meet all the requirements, namely Infit MNSQ (Mean Square) is between 0.5 <X <1.5. Outfit ZSTD (Z-Standard) is between -2.0<X<2.0. And the PT Measure Corr is between 0.4<X<0.85.

Level of Difficulty

The order from difficult to answer to simple, is indicated by the difficulty of their items. The logit value for each item as determined by the Rasch model study was used to order these items. Items and persons (respondents) in the Rasch model can be ordered according to their logit values, and the Rasch model also displays a logit map depicting the distribution of items and respondents according to their logit values along the y-axis. The distribution of items and respondents in the Rasch model analysis is shown in the following logit map.

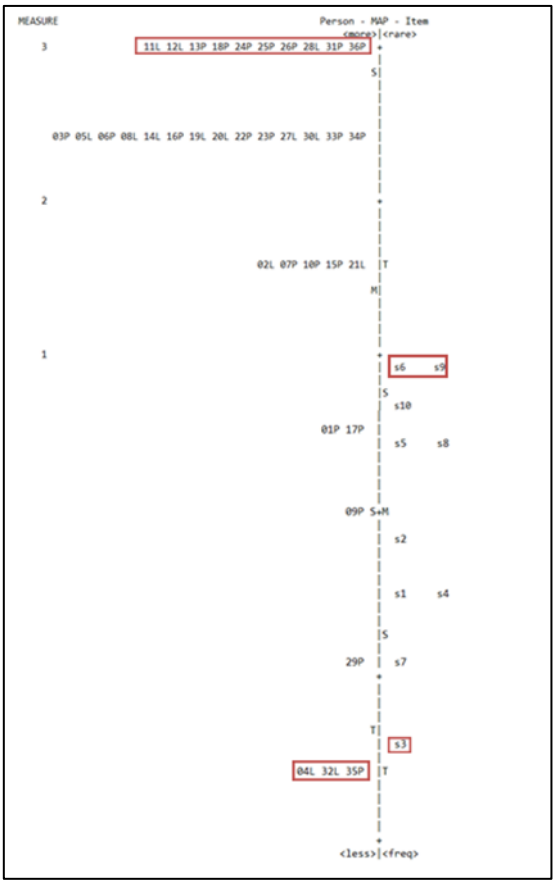


FIGURE 5. Logit Map of Items and Respondents

The left part of the logit map above depicts the distribution of items, while the right area depicts the distribution of respondents. The most difficult items to answer, i.e. those for which respondents answered the least accurately, are positioned to the right of items S6 and S9, which are at the top. While question S3 at the bottom was the simplest to respond to, it also received the most accurate responses from respondents. The easiest respondents to answer correctly in the right areas were those with numbers 11, 12, 13, 18, 24, 25, 16, 28, 31, and 36, while the most difficult respondents to answer correctly were those with numbers 4, 32, and 35.

Questionnaire Results

After completing the experiment in the class, the researcher distributed a questionnaire with a total of 10 questions to find out the students' response to learning activities. The results of the questionnaire can be seen in the TABLE 1.

TABLE 1. Logit Map of Items and Respondents

Questionnaire Questions	Answer Response (Number of People)			
	1 (strongly disagree)	**2 (disagree)**	**3 (agree)**	**4 (strongly agree)**
Learning with uno cards is very enjoyable for me.	0	0	16	20
Learning with uno cards has increased interaction with the teacher.	0	1	12	23
Learning with uno cards makes me understand the material better.	0	1	16	19
Learning with uno cards makes me more motivated to learn.	0	0	18	18
Learning with uno cards makes me not bored when learning in class.	0	0	11	25
Learning done with uno cards is in accordance with the learning I want.	0	0	17	19
Learning with uno cards makes me interested in physics.	0	0	18	18
Learning with uno cards allowed me to work together with my classmates.	0	1	7	28
The lesson changed my thinking about monotonous physics.	0	0	12	24
The lesson made me more courageous in expressing my opinion and answering the questions posed.	0	0	15	21

While the results of the Rasch model analysis can be seen in FIGURE 6.

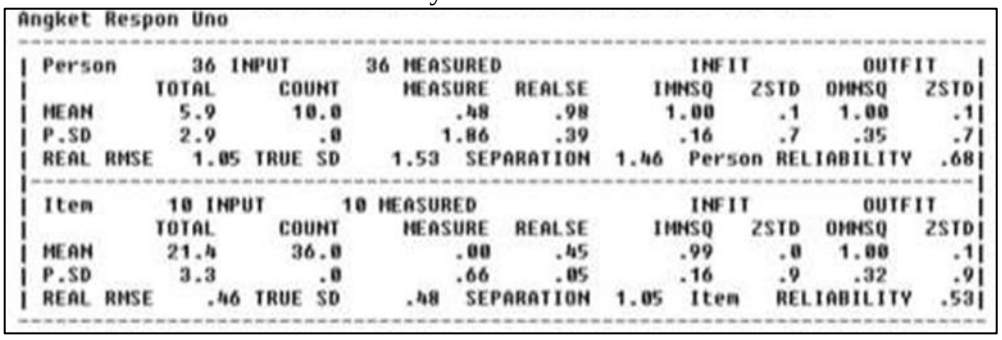


FIGURE 6. Questionnaire Analysis Results using Ministep

Based on the output of the Rasch model above, the data that can be used is INFIT MNSQ and OUTFIT MNSQ, for the ideal value is 1.00 (the closer to 1.00 the better); for INFIT ZSTD and OUTFIT ZSTD, the average value in the table person the ideal value is 0.0 the closer to the value of 0.0, the better the quality (Sumintono, 2015). The results of the analysis using the Rasch model show that the data meet the fit criteria based on the INFIT and OUTFIT Mean Square (MNSQ) values, as well as INFIT and OUTFIT Z-Standard (ZSTD), in accordance with the standards proposed by Sumintono (2015). INFIT MNSQ and OUTFIT MNSQ values close to 1.00 indicate that the data has a good fit with the Rasch model. This means that the items on the instrument can measure students' abilities consistently and as expected, without any answer patterns that deviate from the expected model. With the mean INFIT ZSTD and OUTFIT ZSTD values close to 0.0, we can conclude that the quality of the instrument is good enough to measure students' understanding with little or no significant deviations.

The summary statistics showing MNSQ outfit values around 1.00 and ZSTD outfit values close to 0.0 indicate that students' responses to the items in the instrument are at a level appropriate to their abilities. This indicates that the instrument is effective in measuring students' responses regarding their engagement and understanding in learning with the Teams Game Tournament (TGT) method.

Looking at the data from the summary statistics, the Outfit MNSQ value, and Outfit ZSTD data are ideal because the outfit MNSQ value shows a value of 1.00 so that the value is ideal and for the outfit ZTSD value it is also ideal. These ideal results are in accordance with the results of the following google form response questionnaire where the scale of choice in the written questionnaire is between 1 to 4 where 1 states strongly disagree and 4 states strongly agree. Furthermore, the questionnaire results show that most students agree that the TGT method makes learning more interactive and interesting, based on the questionnaire scale which ranges from 1 (strongly disagree) to 4 (strongly agree). Students considered that TGT helped to increase their activeness and reduce boredom in class. This means that the application of TGT method not only improves conceptual understanding, but also enriches students' learning experience, creating an environment that supports active learning.

Based on the table of questionnaire results above, it shows that the learning process using the Teams Game Tournament (TGT) method can increase student activeness and make the student learning process in class not boring. Overall, the analysis with the Rasch model that produces ideal INFIT and OUTFIT values corroborates the questionnaire results, where students feel more involved and motivated in the learning process. These findings indicate that the instruments used in this study are valid and reliable for measuring students' responses to the TGT method and can support increased student engagement in the learning process.

Empirical studies show that the use of TGT on sound with Uno card media can increase student engagement and understanding. The results of the Rasch model show that this instrument has high reliability and is able to provide a more in-depth analysis of the level of student understanding.

For example, research by Lestari (2022) found that the use of TGT based on Uno cards in physics lessons increased student learning motivation and concept understanding. Rasch analysis in this study showed that students with different ability levels could actively participate and gain better understanding through competition and discussion in groups.

CONCLUSION

The Teams Game Tournament (TGT) cooperative learning model instrument shows valid and reliable results while the level of difficulty of the questions is at the easy, medium, and difficult levels. And through the results of the questionnaire distributed showed that the Teams Game Tournament (TGT) cooperative learning model was effectively used to increase student activeness in class and provide new nuances of physics learning that were not monotonous.

The use of TGT model with Uno card media on topic of sound can increase student engagement and strengthen their understanding of basic physics concepts. The Rasch model provides a more objective way of evaluating the effectiveness of this learning instrument, as well as assisting teachers in identifying aspects that need to be improved to better meet students' needs.

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