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A Rasch model analysis of the TPACK instrument in the creative teaching of primary mathematics teachers

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Abstract

Utilising the Technological Pedagogical Content Knowledge (TPACK) instrument, mathematics teachers were evaluated on their level of TPACK in their creative teaching practices. Using Rasch model analysis, this study aimed to assess the validity and reliability of the TPACK instrument. A 30-item survey with a 5-point Likert scale was given at random to 77 primary school teachers. In order to analyse the data and evaluate the instrument using the Rasch model analysis test, including the item and person separation and reliability index, misfit items, item polarity and unidimensionality, Winsteps 5.2.2.0 software was used. The findings demonstrated a significant Cronbach's Alpha (KR20). In conclusion, this TPACK instrument has high validity and reliability for assessing knowledge in the creative teaching of mathematics teachers.

Keywords: Creative teaching, mathematics, Rasch model analysis, teachers.

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1. Introduction

The advancement of technology has created difficulties in integrating technology in the classroom. Creativity is also closely related to the issue of technology integration which needs to be considered in line with technological developments (Bereczki & Kárpáti, 2021). To fulfil the 21st-century learning demands, the educational sector must consider the use of creative teaching practices that are in motion with technological development (Henriksen, 2016). Technology's rapid advancement has transformed teaching and learning to innovate, as well as the ability to create and share ideas and content. Furthermore, as technology advances in the Industry 4.0 era, incorporating technology into teaching has become one of the requirements of creative teaching practice (Henriksen et al., 2018; Magreñán et al., 2022) and has led to the development of 21st-century learning (Ayyildiz & Yilmaz, 2021; Henriksen et al., 2021). In the classroom, teachers must understand the various ways of integrating technology to creatively and pedagogically present lesson content (Henriksen, 2016). As technology emerges and changes constantly, technology is a target for teachers to implement creative teaching. A creative teaching approach allows teachers to consider how technology integration can help deliver content originally or engagingly (Bereczki & Kárpáti, 2021).

In education, the importance of creative teaching is acknowledged, particularly in the method of instruction and learning (Johansen et al., 2022; Liu & Chang, 2017). The current approach to education needs to consider the creative teaching aspect if it wants to keep students interested both during and after the teaching process. Creative teaching is a distinct and significant process for educational purposes (Beaird et al., 2018; Huang et al., 2019). Mathematics teachers are responsible for supporting their students in creating this knowledge in this situation. Creative teaching is a teacher who plans and uses a variety of existing teaching methods in a new and unique way (Beaird et al., 2018; Soh, 2015). To meet this challenge, mathematics teachers need to continuously update their knowledge (curriculum content), competencies (teaching methods) and technological skills to remain relevant to current and future needs.

Therefore, teachers must always be primed to prepare themselves for various aspects of the formation of 21st-century education. In tackling this challenge, teachers need to find new teaching approaches, methods, strategies and techniques to attract students to the teacher's teaching (Biber et al., 2022; Magreñán et al., 2022). This is because using a range of approaches to instruction in mathematics can help students overcome their aversion to the subject. Students lose interest in and motivation for learning because mathematics is an abstract, challenging and boring subject (Li et al., 2021; Rojas & Carlos, 2020). Thus, the integration of technology is a step to improve the teaching approach in education that can motivate and attract students in mathematics.

1.1 Theoretical framework

Knowledge of technology among teachers is important to operate technology. This is because knowledge of content, pedagogical and future technologies is essential for teachers to implement effective and creative teaching and learning (Henriksen, 2016). Teachers need to select appropriate technology tools based on teaching objectives to ensure that teaching can be implemented effectively (de Freitas & Spangenberg, 2019). In addition, it can also build knowledge of mathematics content that can be absorbed by students easily, enable student-centred teaching and cultivate high-level thinking skills in mathematics teaching. Thus, the framework for Technological Pedagogical Content

Knowledge (TPACK) developed by Koehler and Mishra (2009) can help teachers think about ways to accomplish objectives.

The TPACK Framework is based on Shulman's original concept of Pedagogy Content Knowledge (PCK). Shulman (1987) defines PCK as knowledge held by a teacher who associates pedagogical knowledge with content knowledge to be conveyed to students. On the other hand, TPACK is described as a model and fundamental theory by Koehler and Mishra (2006). It refers to the knowledge needed by teachers to effectively incorporate technology into their lessons. Therefore, TPACK refers to the combination of pedagogical, content and technological knowledge that teachers require to integrate technology into teaching and learning. Knowledge about the interrelationships between pedagogical, content and technological expertise is crucial for facilitating students' learning. Understanding how to use technology is referred to as technological knowledge. Content knowledge is the comprehension of the subject matter that will be taught to students, while pedagogical knowledge refers to the ability to manage students and learning in the classroom. However, the three primary TPACK components eventually grow to seven. Technology Pedagogy Knowledge, Technology Content Knowledge, PCK and TPACK are the four additional knowledge areas.

1.2 Related research

Technology has an impact on the educational sector in terms of curriculum design, teaching methods, learning preparation, experience, classroom objectives and assessment to be in line with the 21st century (Oke & Fernandes, 2020; Tri et al., 2021). Creative and effective teaching requires the teacher's ability to master content knowledge to convey a subject topic to students. In addition, the ability of teachers to their lessons and other learning activities to incorporate technology can stimulate students' interest in learning (McCulloch et al., 2018; Wassie & Zergaw, 2019) and more interesting and effective (Del Cerro Velázquez & Méndez, 2021; Fabian et al., 2018). As a result, student achievement will show a positive increase through teaching and learning which integrates technology (Gurer & Akkaya, 2021). Therefore, the technological knowledge possessed by teachers can be applied as a creative and effective teaching tool, building subject content knowledge that can be absorbed by students more easily, student-centred teaching and fostering higher-order thinking skills in teaching mathematics. Technology integrated into the classroom by itself cannot help students to learn directly, it depends on how the technical knowledge is applied in teaching activities.

Typically, using digital technology, integrating technology and providing students with educational resources are part of teaching activities to improve the level of instruction and learning (Chang & Chen, 2015). In the classroom, teachers need to understand the various technological ways to deliver content creatively with different pedagogies. Through this method, mathematics teachers can consider how technology can be utilised to assist students in learning mathematical content interestingly and originally. This is a new trend for countries that are enhancing educational standards and implementing educational reforms. According to the National Council of Teachers of Mathematics (2014), integrating technology use can improve the efficiency of mathematics instruction, enhance mathematics teaching performance and influence the mathematics taught. Incorporating a technological pedagogy knowledge base into teaching will result in more effective and creative teaching for a teacher.

Numerous research studies have been done to determine how TPACK has affected mathematics teachers' learning (Akapame et al., 2019; Arnan et al., 2021; Große-Heilmann et al., 2022; Puspitasari et al., 2020). Some studies are also being conducted to evaluate the TPACK in secondary school teachers (Lestari et al., 2020; Nurul Shahhida et al., 2019; Saubern et al., 2020). Nevertheless, few studies measure TPACK more than primary school teachers, especially in mathematics (Suryani et al., 2021). Hence, to determine primary school teachers' TPACK in mathematics subjects, the author is eager to evaluate the TPACK component.

According to the TPACK framework, teachers in the classroom have specialised knowledge by combining technological, pedagogical and content knowledge. This TPACK framework does not provide content, pedagogical approaches and types of technology to be used in teaching (Henriksen et al., 2016), but teachers must think in terms of suitability and creativity to achieve teaching objectives. In addition, TPACK also focuses on the ability of new and effective tools and methods as well as helping teachers use creativity as a driver for creative teaching with technology. Therefore, it is important to know the knowledge of Mathematics teachers while integrating technology into creative teaching through this TPACK instrument.

1.3 Purposed of study

Therefore, it is necessary to evaluate the TPACK scale to provide a reliable assessment of the knowledge of using technology in creative teaching mathematics teachers. Any data processing must take the validity and reliability of the instrument into consideration. An instrument's validity is determined by how well it captures the desired result (Creswell, 2014), whereas reliability relates to concepts related to the consistency and stability of the instrument (Cohen et al., 2011; Creswell, 2014). Using the Rasch model analysis, researchers can modify or eliminate unsuitable items to ensure that the scale evaluates what is aimed (Singer, 2016). Before use, this TPACK scale should be evaluated because it can provide more pertinent information about the understanding of technology adoption by mathematics teachers in creative teaching. Therefore, the goal of this research was to assess the instrument used to measure TPACK in Mathematics teachers' creative teaching in terms of its validity and reliability.

2. Method and material

2.1 Research model

A survey is used in this study as a quantitative method. There are various scholarly perspectives on the advantages of quantitative methods. Survey methods can provide precise measurements, generalizability and adaptability (Babbie, 2014). Furthermore, according to Creswell (2014), survey research methods can provide an effective and practical explanation for studying a phenomenon. The survey method is appropriate for gathering information about a recent event. This method enables researchers to conclude a problem based on their perceptions. As a result, this method focuses on people's opinions, beliefs, attitudes and behaviour (Denscombe, 2010).

2.2 Participant

The study was conducted as a survey of primary school mathematics teachers. Sample selection was made randomly. Samples involved in the pilot test study were a total of 77 mathematics teachers. The quantity of respondents in this study is satisfactory because, as per Cooper and Schindler (2014) the suitable number of respondents in the pilot concentration goes from 25 to 100 individuals, while

Johanson and Brooks (2010) recommend the base number is upwards of 30 individuals for a pilot concentrate on whose object is for beginning review or scale improvement. Respondents for this pilot study consisted of 31.2% male teachers and 68.8% female teachers. In addition, the respondents of this pilot study also consisted of teachers who were less than 30 years old, 7.8%. The rest of the respondents are teachers aged between 31–40 which is 22.1%, 41–50 which is 58.4% and 50–60 which is 11.7%.

2.3 Data collection tools

In this study, a questionnaire form served as the main instrument. According to Shaughnessy et al. (2012), if administered and used systematically, the questionnaire form is an effective scientific instrument for measuring study variables. To collect data, appropriate questionnaire instruments are primarily used in quantitative research (Babbie, 2014). According to Sekaran and Bougie (2009), the use of questionnaires allows researchers to obtain feedback and information from many respondents at the same time.

Therefore, the TPACK instrument for mathematics teachers is adapted from Alshehri (2012) and Schmidt et al. (2009). The 30-item survey has a 5-point Likert scale with the options strongly disagree to strongly agree. The data were entered using Statistical Package for the Social Sciences 26.0, and they were cleaned for analysis using Winsteps 5.5.2.0. This model was chosen because it can perform in-depth analysis, particularly an examination of the functionality of the instrument's items, and it provides useful statistics in testing the reliability of the items (Bond & Fox, 2015). Before the instrument is used in the context of the research, this is done to ensure the instrument's quality and the accuracy of the data the researcher has collected.

3. Data analysis and result

The instrument's validity and reliability were evaluated using the item and person separation and reliability index, misfit items, item polarity, unidimensionality and item person map. The Rasch model approach is used concerning values reliability and item separation to assess the reliability of the instrument's items. Furthermore, as shown by the infit values of mean square (MNSQ) and MNSQ outfits, misfit items are used to confirm that the created items are appropriate for measuring constructs. Additionally, the classification of item polarity analyses the appropriateness of the created build in achieving its goal by using the point measure correlation (PTMEA CORR) value. The item measures the construct under consideration if the value in the PTMEA CORR section is positive (Linacre, 2018). The developed item fails to measure the considered construct if the coefficient is negative. If the item is not suited to questions or is tough for respondents to answer, it must be repaired or dropped. Furthermore, unidimensionality is necessary to ensure that the developed instrument can only measure in one direction and that the study's results are not deceptive. Finally, the Rasch model describes the correlation between a person's ability and item uncertainty using an item-person map.

3.1 Person and item separation and reliability

The reliability level is determined using the Rasch measurement model approach, and Cronbach's Alpha values, which range from 0 to 1.0, are used. When it is close to 1.0, Cronbach's Alpha is a reliable indicator. Through this analysis, separators for both items and persons were discovered. The item and person separation index measure the instrument's ability to distinguish between people and items (Bond & Fox, 2015). It is preferable to have a separation of items and people greater than 2.0.

Table 1. Person and Item Separation and Reliability

Criteria	Person	Item
Separation	4.27	3.49
Reliability	0.95	0.92

A statistical summary of the TPACK instrument is shown in Table 1. The separation index reveals the degree of difficulty for both items and people. The Cronbach's Alpha coefficient (KR-20) displayed is 0.95. This value is excellent because the Cronbach Alpha is close to 1.0. The item's quality also demonstrates that it can separate people with a high separation index. The person separation index has a value greater than 2.0, which is 4.27. The value of this person separator demonstrates that there are four stages of individual ability to respond to the items in the TPACK instrument of creative teaching of mathematics teachers.

According to the data analysis, the item separation index value for this instrument is 3.49, and the reliability is 0.92. When the consistency value is greater than 0.8, it is considered to be strong; when it is between 0.6 and 0.8, it is less strong; and when it is less strong, it is not accepted (Bond & Fox, 2007). This value is interpreted as high and indicates this instrument has a clear separation between difficult items and those which are easily answered by the respondent. This means that the items in the construct of this instrument are capable of distinguishing respondents into two levels of ability. A test with a high degree of consistency indicates that the results are close or the same, indicating that the test is relevant and appropriate for use by all groups. As a result, the separation index and person and item reliability of this study were both satisfactory.

3.2 Misfit item

When determining item fit, it's crucial to consider the fit of the items that measure a construct. It is necessary to examine the research data to establish whether the items are suitable for measuring the construct. The ratio of chi-square, which is infit and outfit MNSQ, is a statistic used in Rasch measurement analysis to assess the appropriateness of items. Typically, the outfit MNSQ index is checked first, then the infit MNSQ index. Besides, a Likert scale instrument with a range of 0.5–1.5 is used to identify inappropriate items in polytomous data (Boone et al., 2014). The item is deceptive if the value of the obtained item is greater than 1.5. The item is too readily anticipated by the respondent, however, and there is an overlap of items with other items if the value of the item is less than 0.5 (Linacre, 2018). However, an MNSQ that is out of the MNSQ range will usually show a Z_{std} value.

The standard value of Z, or Z_{std}, is also important in determining an item's suitability. Z_{std} values are accepted in the −2.00 to 2.00 range. The Z_{std} value can be disregarded if the MNSQ value is satisfactory. Table 2 shows the study's misfit items.

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Table 2. Misfit Item

Item	Measure	Infit		Outfit		PTMEA CORR
		MNSQ	Z_{std}	MNSQ	Z_{std}	
D17	−0.49	1.96	3.37	2.04	2.36	0.52
D5	2.77	1.05	0.34	1.68	2.51	0.73
D10	−1.11	1.33	1.27	1.54	1.36	0.55
D26	1.74	1.15	0.87	1.46	1.60	0.72
D8	−1.11	1.45	1.62	0.75	−0.60	0.66
D7	−0.59	1.42	1.68	1.25	0.76	0.50
D2	1.34	1.29	1.52	1.34	1.16	0.64
D3	0.71	1.21	1.08	1.34	1.06	0.67
D9	−1.23	1.15	0.65	1.21	0.64	0.65
D20	−1.60	1.15	0.61	1.19	0.59	0.54
D1	2.43	0.86	−0.79	1.11	0.50	0.72
D6	1.06	0.96	−0.14	1.09	0.38	0.71
D12	−1.35	1.08	0.40	0.86	−0.25	0.64
D14	0.65	1.07	0.44	0.97	0.00	0.60
D4	1.44	0.82	−1.02	1.06	0.32	0.72
D21	−0.49	0.95	−0.14	1.04	0.24	0.63
D11	0.83	0.88	−0.61	0.91	−0.21	0.68
D19	0.52	0.89	−0.55	0.75	−0.72	0.62
D25	−0.89	0.88	−0.44	0.72	−0.70	0.56
D15	0.17	0.86	−0.67	0.61	−1.21	0.64
D22	−0.40	0.84	−0.66	0.62	−1.13	0.64
D23	−0.31	0.79	−0.96	0.58	−1.27	0.66
D18	−0.89	0.78	−0.86	0.58	−1.24	0.66
D30	−0.23	0.72	−1.34	0.73	−0.73	0.59
D27	−0.23	0.67	−1.64	0.48	−1.73	0.66
D16	−0.79	0.66	−1.54	0.65	−0.97	0.49
D24	−0.40	0.66	−1.67	0.53	−1.49	0.60
D29	0.02	0.64	−1.91	0.45	−1.90	0.69
D13	−1.48	0.48	−2.33	0.62	−0.99	0.59
D28	−0.06	0.62	−2.03	0.42	−2.02	0.65

The analysis in this instrument reveals that the outfit MNSQ is between 0.42 and 2.04, while the infit MNSQ is between 0.48 and 1.96. There have been six items that did not fit the MNSQ range based on the outfit. The items over 1.5 were D17 (2.01), D5 (1.68) and D10 (1.54). Otherwise, D27 (0.48), D29 (0.45) and D28 (0.42) were the items below 0.50. The researcher decided to refine item D17 because it was one of the six items with MNSQ scores that fell outside the appropriate range for infit and outfit. Item D17's score of 1.96 was above the cutoff for acceptable results. The item was enhanced in terms of validity after considering the study’s objective.

3.3 Polarity item

By determining the PTMEA CORR, item polarity is used in the Rasch measurement model to detect construct validity in advance (Bond & Fox, 2015). Positive and negative values are indicated by item polarity values (PTMEA CORR). The item polarity is the primary result to be alluded to and was utilised to decide to develop approval by utilising PTMEA CORR coefficient to find a correlation coefficient of the estimation point (Bond & Fox, 2015). The item can distinguish between people's abilities if the PTMEA CORR values are high. Assessment of item polarity by inspecting the size relationship esteem focus point (PTMEA CORR) is expected to identify how far the development of the build accomplishes its objective through positive qualities and negative qualities. On the off chance that the worth found on the PTMEA CORR segment is positive, it shows the item estimates a build that needs to be estimated, in any case, on the off chance that the worth demonstrated is zero or negative, it shows the grew item has not estimated the development to be estimated (Linacre, 2018). The item that demonstrates worth of nothing or negative should be rectified or dropped because the item didn't highlight an inquiry or is challenging to reply to by respondents.

From Table 3, all PTMEA CORR values for 30 of the investigated things showed positive qualities. The base and most extreme PTMEA CORR values were 0.50 and 0.73, individually. The PTMEA CORR esteem is more than 0.50. Luckily, there were no PTMEA CORR values that were zero or negative. Subsequently, the item in this TPACK instrument was reliable with different things used to survey mathematics teachers' information in imaginative education. Hence, it is possible to conclude that the item enhances the evaluation of the TPACK tools used by mathematics teachers. The TPACK instrument can distinguish between or identify different types of knowledge that mathematics teachers possess.

Table 3. Polarity item

Item	Measure	INFIT		OUTFIT		PTMEA CORR
		MNSQ	Z_{std}	MNSQ	Z_{std}	
D17	−0.49	1.96	3.37	2.04	2.36	0.52
D5	2.77	1.05	0.34	1.68	2.51	0.73
D10	−1.11	1.33	1.27	1.54	1.36	0.55
D26	1.74	1.15	0.87	1.46	1.60	0.72
D8	−1.11	1.45	1.62	0.75	−0.60	0.66
D7	−0.59	1.42	1.68	1.25	0.76	0.50
D2	1.34	1.29	1.52	1.34	1.16	0.64
D3	0.71	1.21	1.08	1.34	1.06	0.67
D9	−1.23	1.15	0.65	1.21	0.64	0.65
D20	−1.60	1.15	0.61	1.19	0.59	0.54
D1	2.43	0.86	−0.79	1.11	0.50	0.72
D6	1.06	0.96	−0.14	1.09	0.38	0.71
D12	−1.35	1.08	0.40	0.86	−0.25	0.64
D14	0.65	1.07	0.44	0.97	0.00	0.60
D4	1.44	0.82	−1.02	1.06	0.32	0.72
D21	−0.49	0.95	−0.14	1.04	0.24	0.63
D11	0.83	0.88	−0.61	0.91	−0.21	0.68
D19	0.52	0.89	−0.55	0.75	−0.72	0.62

D25	−0.89	0.88	−0.44	0.72	−0.70	0.56
D15	0.17	0.86	−0.67	0.61	−1.21	0.64
D22	−0.40	0.84	−0.66	0.62	−1.13	0.64
D23	−0.31	0.79	−0.96	0.58	−1.27	0.66
D18	−0.89	0.78	−0.86	0.58	−1.24	0.66
D30	−0.23	0.72	−1.34	0.73	−0.73	0.59
D27	−0.23	0.67	−1.64	0.48	−1.73	0.66
D16	−0.79	0.66	−1.54	0.65	−0.97	0.49
D24	−0.40	0.66	−1.67	0.53	−1.49	0.60
D29	0.02	0.64	−1.91	0.45	−1.90	0.69
D13	−1.48	0.48	−2.33	0.62	−0.99	0.59
D28	−0.06	0.62	−2.03	0.42	−2.02	0.65

3.4 Unidimensional

The unidimensional list assesses the instrument utilising Residual Principal Component Analysis. The requirement for unidimensionality should be met by instruments. It is useless to consider persons or items while counting the overall aggregate if unidimensionality is not met (Boone et al., 2014). Linacre (2018) expressed that the base change expected to show the instrument's unidimensionality is 20%, though Sumintono and Widhiarso (2015) express that the worth of acknowledgment prerequisites should be least and more prominent than 40% to be viewed as good. The unexplained variance in the first contrast ought not to be more noteworthy than 15% (Fisher, 2007). Table 4 presents the standardised residual variance for this instrument.

Table 4. Standardized Residual Variance

		Empirical		***Modelled***
Total raw variance in observations	62.0	100.00		100.00
Raw variance explained by measure	32.0	51.7		50.5
Raw variance explained by persons	23.7	38.3		37.4
Raw variance explained by items	8.3	13.4		13.1
Raw unexplained variance (total)	30.0	48.3	100.0	49.5
Unexplained variance in first contrast	5.2	8.3	17.3	
Unexplained variance in second contrast	2.7	4.4	9.1	
Unexplained variance in third contrast	2.2	3.6	7.4	
Unexplained variance in fourth contrast	2.0	3.3	6.9	
Unexplained variance in fifth constrast	1.9	3.0	6.3	

As the result, the raw variance explained by the measure was 51.7%, which was 1.2% more than the modelled. Furthermore, the variance is greater than 40%, indicating that this instrument is unidimensional. In the first contrast, the eigenvalue of unexplained variance is 5.2 units and addresses 8.3%, which can be acknowledged as under 15%. Consequently, the given instrument is solid in estimating the development of TPACK in the imaginative education of mathematics teachers. A unidimensional development measures what it professes to gauge.

In addition, the standardised residual correlation should also be examined to determine whether the variables are dependent on one another. The items are subject to one another rather than just one another, as evidenced by the standardised residual correlation values greater than 0.7 (Linacre, 2018). According to Table 5, no item on this instrument has a standardised residual correlation that is more pronounced than 0.7.

Table 5. Standardized Residual Correlation

Correlation	Entry number	Item	Entry number	Item
0.61	21	D21	22	D22
0.59	21	D21	23	D23
0.57	22	D22	23	D23
0.55	4	D1	6	D6
0.55	13	D13	16	D16
0.54	25	D25	28	D28
0.51	20	D20	21	D21
0.49	1	D1	5	D5
0.49	3	D3	4	D4
0.47	13	D13	24	D24
0.45	9	D9	21	D21
0.45	4	D4	5	D5
0.44	27	D27	28	D28
0.44	22	D22	27	D27
0.42	9	D9	12	D12
0.42	28	D28	29	D29

3.5 Item person map (Wright map)

The item person map shows the distribution of items and person capabilities in a Rasch analysis. The item person map has item positions on the right and person positions on the left (Bond & Fox, 2015). Mapping this is intended to show the connection between a level item difficulty and a person's abilities. Rankings at the top of the scale show persons with high abilities and the most difficult items while persons with low capacities and the simplest items are at the lower part of the scale. From Figure 1, in the logit scale which ranges from 2.40 to −1.77 logits, item D5 is the most challenging, while item D20 is the easiest. The acceptable range for logits is −3 to 3 logits, and the logit range between −1.77 and 2.0 fulfilled this range (Linacre, 1994). No item can be used to test a person's ability who has a logit score higher than three or lower than two, according to the results.

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MEASURE    Person - MAP - Item
               <more>|<rare>
   11             X  +
                     |
                  X  |
   10                +
                  X  |
                     |
    9                +
                     |
                     |
    8                +
                     |
                     |
    7            XX T+
                     |
                  X  |
    6             X  +
                XXX  |
                     |
    5             X  +
                    S|
                 XX  |
    4  XXXXXXXXXXXX  +
                     |
                  X  |
    3                +
              XXXXX  |  D5
                 XX M|T D1
    2             X  +
               XXXX  |  D26
             XXXXXX  |  D2      D4
    1           XXX  +S D6
      XXXXXXXXXXXXX  |  D11     D14     D19     D3
              XXXXX  |  D15
    0          XXXX S+M D28     D29
                XXX  |  D17     D21     D22     D23     D24     D27     D30
                XXX  |  D16     D7
   -1             X  +S D10     D18     D25     D8
                     |  D12     D13     D9
                  X  |  D20
   -2                +
               <less>|<freq>
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Figure 1. Item Person Map

4. Discussion

A framework for creative and effective teaching that integrates technology, pedagogical methods and content is known as TPACK. That is, to effectively and creatively teach content, technology must be used in conjunction with pedagogical techniques. Teachers' knowledge is required in this framework in terms of concepts and pedagogical methods. Pedagogical technology is used to represent the concepts and techniques for assisting students in overcoming learning difficulties. It's important to reinforce students' previous understanding when using the TPACK framework. To possess such knowledge, teachers must learn the three TPACK components (Koehler & Mishra, 2009). Hence, the TPACK instrument can provide a valid measure for measuring mathematics teachers' understanding of the integration of technology in creative teaching using Rasch model analysis.

The validity and reliability of the TPACK instrument in the creative teaching of mathematics teachers were examined in this study using Rasch model analysis. A method used in a pilot study to improve the quality of prospective questionnaire items was used to evaluate validity and reliability in actual studies. According to an analysis of the instrument's reliability through item functionality, all of the items in this instrument have passed three inspection criteria: the item and person separation and reliability index, the item polarity through value PTMEA CORR and the items based on standardised residual variance. Nevertheless, the analysis of misfit items indicates that one item is unacceptable. However, after considering the goal of this study, the researchers chose to drop this item (D17) based on advice from experts. Rasch model analysis revealed that 29 TPACK items in total had positive item characteristics. Its application is particularly appropriate in the context of primary school mathematics teachers' innovative instruction. Overall, the validity and reliability of this instrument for use in assessing the TPACK knowledge of mathematics teachers could be confirmed.

Therefore, based on the pilot study conducted, it is possible to formulate that validity and reliability is one of the important aspects and need to be carried out before developing a new instrument. This is because an authentic instrument will be formed which allows the measurement to be measured with expected accuracy. This demonstrates that the instrument that has been cleaned can now display qualities and have higher reliability. Additionally, this study inadvertently demonstrates how much teachers typically incorporate technology into their instruction. Additionally, this analysis can look at which TPACK knowledge is the hardest to pinpoint and which is the simplest to improve. Therefore, it is also hoped that this research will result in the creation of tools to evaluate teachers' abilities, particularly those of primary school teachers. Unquestionably, assessing teachers' skills can help to raise educational standards and give the government a framework for developing policies that will help teachers develop their professionalism.

However, this study also has implications from a literature, methodological and practical standpoint. In addition, this study also gives implications to the literature on the Rasch measurement model. The findings of this study confirm that the use of the Rasch measurement model can confirm the reliability and validity of an instrument by taking into account the recommendations made by Bond and Fox (2015); Boone et al. (2014) and Linacre (2018). The study's analysis revealed that TPACK instruments are appropriate for use in the context of mathematics education to measure TPACK knowledge in creative teaching methods, which has the most obvious practical implications in addition to ensuring the validity and reliability of the instrument. Teachers enhance creative teaching practices by fusing technology, pedagogy and content. This helps to create the kind of innovative and creative generation that the country wants. To check the validity and reliability of the TPACK instrument, however, methodological implications lead to the use of the Rasch measurement model, which can assess item and respondent reliability in greater detail. The Rasch measurement model allows the removal of items that do not meet the inspection range and can measure respondent and item reliability more thoroughly and more strongly than simply looking at Cronbach's Alpha. In light of this, the implications methodology of validity analysis and strict reliability with Rasch model analysis provides more comprehensive analytical strategies and generates instruments that can be reliable.

5.0 Conclusion

Testing for validity and reliability are two essential steps that need to be taken. The researcher can ensure that the administered questionnaire can address the research questions and be used effectively in the actual study with the help of the validity and reliability analysis results. The findings of this study demonstrate that primary school mathematics teachers can use the TPACK instrument to evaluate their level of TPACK in creative teaching. However, there is a limitation in this study that is only for primary school mathematics teachers. Based on their perception and teaching experience, all data obtained is based on feedback from teacher respondents who teach primary school mathematics subjects. To collect research data, a survey study was conducted only once during a specific time period, using a questionnaire. The study's findings are also dependent on the respondents' honesty in providing accurate and true answers based on the questionnaire submitted.

Teachers' creative teaching in schools, particularly in the classroom, can help students develop their potential and make learning more dynamic, fresh and effective as the foundation of students’ academic achievement and personality. Along with the current circulation and needs, there is agreement that integrating technology into the process of teaching and learning is a necessity that must be implemented wisely so that the results obtained can benefit all parties. The ability to integrate these two elements will result in an effective process of teaching and learning that takes the needs of those elements into account. The incorporation of these elements has been proposed in the TPACK model.

6.0 Recommendation

Teachers' creative teaching in schools, particularly in the classroom, can help students develop their personal potential and make learning more dynamic, fresh and effective as the foundation of student's academic achievement and personality. Along with the current circulation and needs, there is agreement that integrating technology into the teaching and learning process is a necessity that must be implemented wisely so that the results obtained can benefit all parties. The ability to integrate these two elements will result in an effective teaching and learning process that takes the needs of those elements into account. The incorporation of these elements has been proposed in the TPACK model. The TPACK framework brings challenges to its implementation in the classroom. Not all teachers can deliver lessons with technology integration effectively.

Therefore, future research can focus on other aspects related to TPACK for teachers. Furthermore, the items provided in the instrument should be adapted to the teacher's preferences to maximise the overall efficiency of the instrument. The prepared instrument should include more items with non-overlapping descriptions and similar meanings or interpretations. This can be used to determine TPACk teachers' level of knowledge in other fields. Before conducting a Rasch model analysis, a more in-depth research is required to identify more relevant topics.

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