Validity and Reliability of Teachers Mathematics Knowledge Scale

ABSTRACT

Mathematical knowledge is very important to the mathematics teacher. The aim of this study is to validate the mathematical knowledge scale based on the Earnest Framework in the Malaysian version. The respondents are 150 mathematics teachers from the north of Malaysia. The validity of the scale is determined by using exploratory factor analysis with principal components analysis and varimax rotation. The number of factors through eigenvalues greater than one and frames the structure of the scale through factor loading re determined. The value of the eigenvalue and factor loading are considered in this research to frame and develop the structure of the scale. The reliability is tested with Cronbach's alpha. The findings showed that six factors on the scale explaining 67.39% of the variances. 26 items with factor loading greater than 0.60 were determined for the scale. The structure of the scale was as follows; three items in the first factor, two items in the second factor, five items in the third factor, four items in the fourth factor, ten items in the fifth factor, and two items in the sixth factor. The reliability of the scale was 0.958. In conclusion, the scale is valid and reliable in measuring teachers' mathematics knowledge.

Keywords:exploratory factor analysis, Ernest framework, mathematic knowledge, principal component analysis.

Comment [U1]: State with the title of the study: eg.Validity and Reliability of Teachers Mathematics Knowledge Scale

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Comment [U3]: Add, Validity, Reliability, Teachers, Mathematics knowledge as part of the key words and remove key words not caputred in the body of the study

INTRODUCTION

Mathematical knowledge is important for students to master. According to Arseven (2015), mathematics is the most common comprehension subject because it can be used in various areas, even those which are not related to the mathematics field. Mathematical knowledge consists of several skills, namely problem solving, reasoning, connecting and representing (Marasabessy, 2012). Therefore, according to (Nadarajan, 2023), students will face problems in reasoning, reflecting, making decisions, innovating, and creating something if they do not master mathematical knowledge. Hill et al (2020) stated that mathematics is the gatekeeper subject because it benefits the life span, improves employment chances, and informs choices about the environment, health, and wellbeing. The benefits of mathematic knowledge acquired through mathematics lead to logical thinking, daily life problem solving, recognising patterns of relationships, developing creativity, and increasing awareness (Hasibuan et al, 2018). According to Tato et al (2013), the main purpose of mathematics education is to enable students to solve their daily life problems. Mastering mathematics equips students with deep critical and analytical skills (Rohid et al, 2019). Countries such as the UK, USA, Finland, and Australia believed that mathematical knowledge improved students thinking capacity as well as their critical, creative, and logical understanding of daily life situations (Yilmaz, 2019).

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Regarding the importance of mastering mathematical knowledge, Malaysian students were found to have a lower score in mathematics assessments. However, in the earlier test, Malaysian eighth graders in TIMSS showed declining trends. As stated by Yang & Sianturi (2020)Malaysia was frequently ranked at the bottom in the TIMSS test. Alhassora and Abdullah (2017) also stated that the scores of Malaysian students in TIMSS and PISA were less than satisfactory. For example, in 2011, Malaysia ranked 26th out of 45 countries with a mean score of 440. This score improved in 2015 with an overall score of 465 (Mulis et al, 2016). However, this score decreased in 2018, with an overall score of 440 (Maamin & Iksan, 2021). The low scores of Malaysian students in TIMSS and PISA indicate that their mastery of mathematical knowledge is low.

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The minimum score of Malaysian students in TIMS and PISA might be related to teacher competency in mathematic teaching. Rohid et al (2019)stated that the effectiveness of mathematic learning in the classroom heavily depends on the teacher's ability to facilitate learning. Exactly, teachers hoped to generate an effective and suitable curriculum for mathematical teaching (Arseven, 2015). It is because teachers play an important role in determining the quality of education (Unal, 2017). Van Der Sandt (2007) stated that teachers are the ones who filter the curriculum, which makes them play a central role in bringing out the desired reform in education. The model emphasises teacher mathematical content knowledge (Ernest, 1989), which should be mastered by teachers to be qualified teachers. According to Wilkins (2008), teachers' mathematical knowledge influences their efficacy and choice of instructional practices in the classroom. Van Der Sandt (2007) further explains that mathematical content knowledge includes knowledge of how the student thinks and learns, knowledge of how the student acquires mathematic material, as well as knowledge related to the process of students understanding and difficulties.

Based on the explanation above, there is a need to examine the teacher's mathematical knowledge. The instrument specifically measuring the teacher's knowledge in Malaysian context was not provided in the literature. Exactly, there are several studies that have developed and validated scales to measure teacher math knowledge.

For example, Durmuş and Bıçak (2006)developed a scale to measure the mathematical value of preservice teachers. However, this scale is tested on Turkey participants and does not specifically examine the teacher's mathematical teaching domain. Tatoo et. al. (2013) developed a scale measuring opportunity to learn, belief and mathematic knowledge for teaching only.

RESEARCH OBJECTIVES

The aim of the current research is to validate the Malaysian version of the mathematical knowledge scale based on the Ernest Framework. Factor analysis will be used to validate the scale. Reliability of the scale was tested with Cronbach's alpha.

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RESEARCH METHODOLOGY

This study is using survey method. Questionnaire was used to collect data from the respondents. The total number of participants is 150 mathematics teachers from Kelantan, Malaysia. The sample was chosen based on random sampling method. 26-item questionnaires examining mathematical knowledge were given to the participants. The participants were asked to assess mathematical knowledge. The five-point Likert scale format was used for the questionnaire.The Malaysian version of the mathematical knowledge scale consists of 26 items adopted from the (Rohid *et al*, 2017) Mathematic Knowledge Framework. A 5-point Likert scale (1 = very much disagree, 2=disagree, 3 = neutral, 4 = agree, and 5 = very much agree) was used.

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RESEARCH FINDINGS

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The appropriateness of the dataset to be used in factorial analysis was confirmed through Kaiser-Meyer-Olkin and Barlett`s test of sphericity. In the current research, the result of KMO was 0.842, and Barlett`s test of sphericity was significant, which means the dataset can be used in factorial analysis. The result can be seen in Table 1.

Table 1. The Result of KMO and Bartlett's test

Kaiser-Meyer-olkin	Measure of Sampling Adequacy	0.842
Bartlett's Test of Sphericity	Approx. Chi-Square Sphericity	3025.96
	df	630
	Sig	0.000

A factorial analysis was conducted. Principal components analysis with varimax rotation, and the coefficient was settled to 60 was performed. The data analysis revealed six factors with eigenvalues greater than 1, explaining 67.39% of the variance. Furthermore, the first factor explaining 41.85% of the variance indicates that the dataset is not common method biased. Specifically, the eigenvalue for the first factor was 15.064, the second factor was 2.659, the third factor was 1.970, the fourth factor was 1.722, the fifth factor was 1.481, and the sixth factor was 1.365. The detailed information about the eigenvalue and its variances can be seen in Table 2.

Table 2. Total variance

	Initial Eigenvalues					
	Total	% Of variance	Cumulative %	Total	% Of variance	Cumulative
1	15.064	41.845	41.845	15.064	41.845	41.845
2	2.659	7.385	49.230	2.659	7.385	49.230
3	1.970	5.472	54.701	1.970	5.472	54.701
4	1.722	4.784	59.485	1.722	4.784	59.485
5	1.481	4.113	63.599	1.481	4.113	63.599
6	1.365	3.793	67.391	1.365	3.793	67.391

Extraction method: Principal Component Analysis

After determining the number of factors, the researcher examines the factor loading of each item's, which indicates which factor the items are correlated to, and whether the items will be eliminated or not from the analysis. In the current research, as the participants were 150, the items with a factor loading below 0.60 were eliminated from the analysis (Table 3).

Table 3. Factor and Factor Loading

No	Items	Result of factorloading					
		1	2	3	4	5	6

Factor1:Mathematic content							
1	Covers a variety of procedures	0.602					
2	Covers a variety of strategies	0.622					
3	Strengthen the explanation and demonstration of teaching.	0.601					
Factor2:Related subject							
4	Applying mathematics in related fields		0.721				
5	Shows the relevance of the mathematical content to the student		0.759				
Factor3: Mathematic teaching							
6	Source of the subject's curriculum			0.698			
7	Computer software and teaching equipment			0.657			
8	Mathematical title-related approach			0.686			
9	Defining methods of solution, conceptualizing mathematical concepts, understanding difficulties andcommon student error			0.744			
10	Preparing tasks, activities and descriptions			0.613			
Factor4:Teaching Management							
11	Command to group co-operative				0.750		
12	Asking questions to students in class				0.740		
13	Control aspects likeining order in class				0.708		
14	Accessibility to teaching resources and conducting examinations				0.703		
Factor5:Contextual Teaching							
15	Interactive methods like collaborate in a group					0.752	
16	Student response to learning tasks					0.684	
17	Student's response to teacher's authority					0.696	
18	Colleague and colleague in committee					0.607	
19	Classroom and location of teaching resources such as computer and audio					0.660	
20	Administrative rules and procedures of the teacher performance assessment system					0.670	
21	Out-of-class activities					0.793	
22	School culture					0.647	
23	The administrator's expectations of a teacher' duties					0.734	
24	Diversity of social, cultural and ethnic backgrounds of students					0.621	
Factor6: Knowledge of mathematics education							
25	Multiple mathematical theories						0.688

26	Results of empirical research	0.643

The research confirms six factors with their respective items. Each factor is then named based on the Danışman and Tanışlı (2017) framework. The result showed that the current dataset has a Cronbach alpha of 0.958, which is categorized as a very high value, indicating the scale is valid to be used for research examining mathematical knowledge.

DISCUSSION

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The purpose of this research is to develop the Malaysian version of the mathematical knowledge scale to be used by higher education teachers based on the Danışman and Tanışlı (2017) Framework. In the validation process, many researchers affirm that EFA procedures should be performed for each construction to determine whether the dimensions of the items have changed from previous studies (AlKhameinsah, 20200. The dimension of the item may change when the existing study differs from the previous study in terms of field of study, cultural differences, socio-economic population, and the time interval that is the period of the current study compared to the previous study. This means that the dimensions obtained by previous studies may not last, especially when the current studies are conducted in a new environment (Zainuddin, 2012).

In the Exploratory Factor Analysis of the current research involving a sample size of 150 teachers, the determined factor loading is more than 0.6, as recommended by De Roover, K. and Vermunt, J. K (2019). Hair et al (2014) recommend a load factor of 0.55 and above, which is practically significant for a 150-person study sample. Supported by Baistamam *et al* (2020), which affirms that items are reliable when four or more factor loads have values greater than 0.6, regardless of sample size. The suitability of the sample data for analysis must be determined first by conducting the Kaiser-Meyer-Olkin (KMO) and Barlett's Test of Sphericity tests. For this study, the EFA is consistent with the KMO value of 0.60 as a minimum value for a good factor analysis that indicates that the data does not have a serious multicollinearity problem (Zainuddin, 2012) and in line with the suggestion by Bandalos (2021) that stating KMO values approaching 1.0 can produce reliable and different factors among each other.

This study confirms six factors of the scale, with the total items being 26. The number of factors in this research is concordance to the concept proposed by Ernest (1989) in his research regarding the aspect of mathematics teachers that should be considered. The first factor in the scale is the mathematical content knowledge. In this research, this factor was found to have three items; the mathematical content includes procedures, the mathematical content includes strategies, and strengthening the explanation and demonstration of the content. Mainali (2020) explain it as the pedagogical content knowledge which covers the ability of teachers to represent the subject, which is required for students to understand the materials. This includes analogy, illustration, and representing the mathematical concept in the best way it is possible.

The second factor in the scale is the knowledge of the subject matter, which includes two items which are applying mathematics in a related field and showing the relevance of the mathematical content to the students. Based on the explanation in the introduction to this research, mathematics content can be used in other related fields because it trains students to do problem solving, reasoning, connecting, and representing Marasabessy (2021). Maamin, and Iksan (2021) stated that students need mathematical understanding to produce a workplace and contribute to the country. Mathematic has been integrated into one of the subjects prepared for the industrial work market, namely STEM. Therefore, a mathematics teacher should equip students with mathematical understanding and mastery. To do that, it is related to the third factor of the scale, namely mathematics teaching. Mathematics teaching includes the items of the subject curriculum, integrated technology in teaching, conceptualizing the mathematic materials for the students, and preparing tasks for the students to solve. This strategy aims to enhance the quality of teaching, which can boost student achievement and mastery in mathematics.

The fourth factor on the scale is teaching management. In this research, this factor includes five items which are managing a cooperative group of students, provoking by asking and answering questions in the classroom, ordering the classes, access to teaching resources, and preparing examinations. Mainly, teaching students is ordering them into classroom activities. Eraut (2007) stated that managing the classroom involves utilizing a series of events that occur in the classroom by the teacher in countless ways. Several ways of managing the classroom that can give teachers effective performance are to take actions as the response to the event occurs, pursue specific action, and keep metacognitive monitoring (Emmer, 2012). In this case, monitoring student metacognitive performance is related to assessment actions conducted by teachers.

The fifth factor for the scale was contextual teaching. Contextual teaching includes items such as interactive group teaching strategies, student responses, peer support, the availability of devices to support learning, administrative procedures and procedures of assessment, school culture, outside-class activities, the expectation of the administration of teacher duties, and the background of the students. These variables support the contextual teaching performed by teachers. According to Uslima et al (2018), contextual teaching supported by various equipment could improve students problem-solving abilities, understanding of concepts, and learning outcomes. Orland-Barak and Wang (2020) in their research, found that the use of contextual learning can improve students mathematical understanding. The sixth factor of the scale is the general understanding of the teacher regarding mathematic education, such as theories of mathematics and research related to mathematic education. This is to make sure that teachers have a rich, wide, and comprehensive understanding regarding mathematical education and teaching. Orland-Barak and Wang (2020) emphasize that teacher professional development should develop a more comprehensive and deeper understanding of educational issues. Overall, this research contributes to confirming a valid scale to be used for examining teacher mathematical knowledge.

CONCLUSION

The purpose of the current research was to determine the validity of the Malaysian version of mathematical knowledge of teachers. There are six factors with 26 items framed. The factorial analysis confirmed the structure of the scale. The result of Cronbach alpha confirms that the scale was reliable to be used in the study, with a value of 0.958. Based on the results, the scale is valid and reliable enough to be used to measure teachers' mathematical knowledge.

Comment [U10]: Conclusion requires elaboration as it did not state the position of the study

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

REFERENCES

Abdullah, A., M. Mokhtar, N. D. A. Halim, D. F. Ali, L. M. Tahir, and U. H. A. Kohar. (2016). Mathematics Teachers' level of knowledge and practice on the implementation of Higher-Order Thinking Skills (HOTS). *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 13, no. 1, Oct. 2016, doi: 10.12973/eurasia.2017.00601a.

Alhassora, M. S. Abu, and Abdullah (2017) 'Inculcating higher-order thinking skills in mathematics: why is it so hard?,' *Man in India*, vol. 97, no. 13, pp. 51–62, Jan. 2017, Available: http://eprints.utm.my/id/eprint/76878/

Al-Khamaiseh, B. B. A. Halim, A. Afthanorhan, and A. H. Alqahtani (2020). EXPLORING AND DEVELOPING ITEMS MEASURING SITUATIONAL LEADERSHIP II (SLII). *Humanities & Social Sciences Reviews*, vol. 8, no. 2, pp. 579–588, Apr. 2020, doi: 10.18510/hssr.2020.8266.

Arseven, A. (2015) "Mathematical modelling approach in mathematics education," *Universal Journal of Educational Research*, vol. 3, no. 12, pp. 973–980, Dec. 2015, doi: 10.13189/ujer.2015.031204.

Asempapa, R. S. (2018) Assessing Teachers' Knowledge of Mathematical Modeling: Results from an Initial Scale Development, *Journal of Mathematics Education*, vol. 11, no. 1, pp. 1–16, Mar. 2018, doi: 10.26711/007577152790017.

Baistaman, Z. Awang, A. Afthanorhan, and M. Z. A. Rahim (2020). DEVELOPING AND VALIDATING THE MEASUREMENT MODEL FOR FINANCIAL LITERACY CONSTRUCT USING CONFIRMATORY FACTOR ANALYSIS, *Humanities & Social Sciences Reviews*, vol. 8, no. 2, pp. 413–422, Apr. 2020, doi: 10.18510/hssr.2020.8247.

Bandalos, D. L. (2021) "Item meaning and order as causes of correlated residuals in confirmatory factor analysis," *Structural Equation Modeling: A Multidisciplinary Journal*, vol. 28, no. 6, pp. 903–913, May 2021, doi: 10.1080/10705511.2021.1916395.

Danışman, S and D. Tanışlı (2017) "Examination of Mathematics Teachers' Pedagogical Content Knowledge of probability," *Malaysian Online Journal of Educational Sciences*, vol. 5, no. 2, pp. 16–34, Mar. 2017, [Online]. Available: http://files.eric.ed.gov/fulltext/EJ1142506.pdf

De Roover, K. and Vermunt, J. K (2019) "On the Exploratory Road to Unraveling Factor Loading Non-invariance: A New Multigroup Rotation Approach," *Structural Equation Modeling: A Multidisciplinary Journal*, vol. 26, no. 6, pp. 905–923, Apr. 2019, doi: 10.1080/10705511.2019.1590778.

Durmuş, S. and Bıçak, B. (2006). "A Scale for Mathematics and Mathematical Values of Pre-Service Teachers.," *Online Submission*, Jul. 2006, [Online]. Available: http://files.eric.ed.gov/fulltext/ED495503.pdf

Ehido, Z. Awang, B. A. Halim, and C. Ibeabuchi (2020). Establishing valid and reliable measures for organizational commitment and job performance: an Exploratory factor analysis. *International Journal of Social Sciences Perspectives*, vol. 7, no. 2, pp. 58–70, Jan. 2020, doi: 10.33094/7.2017.2020.72.58.70.

Emmer, E. T. *Handbook of Classroom Management: Research, Practice, and Contemporary Issues*. 2012. Available: https://www.amazon.com/MyEducationLab-Pearson-eText-Standalone-Access/dp/0132909383

Eraut, M. (2007). "Learning from other people in the workplace," *Oxford Review of Education*, vol. 33, no. 4, pp. 403–422, Jul. 2007, doi: 10.1080/03054980701425706.

Ernest, P (1989) "The Knowledge, Beliefs and Attitudes of the Mathematics Teacher: a model," *Journal of Education for Teaching*, vol. 15, no. 1, pp. 13–33, Jan. 1989, doi: 10.1080/0260747890150102.

Finch, W. H. (2019). Using fit statistic differences to determine the optimal number of factors to retain in an exploratory factor analysis. *Educational and Psychological Measurement*, vol. 80, no. 2, pp. 217–241, Jul. 2019, doi: 10.1177/0013164419865769.

Hafnidar, I. Harniati, M. B. Hailemariam, and C. Handrianto. (2021). 'Students Self-Regulation: An Analysis of Exploratory Factors of Self-Regulation scale,' *Spektrum*, vol. 9, no. 2, p. 220. doi: 10.24036/spektrumpls.v9i2.112589.

Hair, Black, Babin, and Anderson (2014). *Multivariate Data Analysis*, 7th ed. Edinburgh Gate, 2014.

Hasibuan, AM. S. Saragih, and Z. Amry (2018). "Development of learning materials based on realistic mathematics education to improve problem solving ability and student learning independence," *International Electronic Journal of Mathematics Education*, vol. 14, no. 1, Dec. 2018, doi: 10.29333/iejme/4000.

Hill, J. M. L. Kern, W. T. Seah, and J. Van Driel (2020). "Feeling Good and Functioning Well in Mathematics Education: Exploring Students' Conceptions of Mathematical Well-Being and Values," *ECNU Review of Education*, vol. 4, no. 2, pp. 349–375, Jul. 2020, doi: 10.1177/2096531120928084.

Kazemi, F. and A. Rafiepour (2017). Developing a scale to measure content knowledge and pedagogy content knowledge of In-Service elementary teachers on fractions. *International Journal of Science and Mathematics Education*, vol. 16, no. 4, pp. 737–757, Jan. 2017, doi: 10.1007/s10763-016-9792-0.

Maamin, S. M. Maat, and Iksan, Z. H. (2021) "Analysis of the factors that influence mathematics achievement in the ASEAN countries," *Cypriot Journal of Educational Sciences*, vol. 16, no. 1, pp. 371–388, Feb. 2021, doi: 10.18844/cjes.v16i1.5535.

Maaß, V. Geiger, A. Quesada, and M. Goos (2019). The Role of Mathematics in interdisciplinary STEM education," *ZDM – Mathematics Education*, vol. 51, no. 6, pp. 869–884, Oct. 2019, doi: 10.1007/s11858-019-01100-5.

Mainali, B. (2020). "Representation in teaching and learning mathematics," *International Journal of Education in Mathematics, Science and Technology*, vol. 9, no. 1, pp. 1–21, Dec. 2020, doi: 10.46328/ijemst.1111.

Marasabessy, R. (2021) "Study of Mathematical Reasoning Ability for Mathematics Learning in Schools: A literature review," *Indonesian Journal of Teaching in Science*, vol. 1, no. 2, pp. 79–90, Dec. 2021, doi: 10.17509/ijotis.v1i2.37950.

Ministry of Education Malaysia (2013). *Malaysia Education Blueprint 2013-2025: Preschool to post-secondary education.* Putrajaya, Malaysia: Ministry of Education Malaysia., 2013.

Mullis, Martin, Foy, and Hooper (2016). *TIMSS 2015 International results in mathematics.* Chestnut Hill: TIMSS & PIRLS International Study Centre, Boston College, 2016.

Nadarajan, K. (2023). "The effectiveness of a Technology-Based isometrical Transformation flipped classroom learning strategy in improving students' higher order thinking skills," *IEEE Access*, vol. 11, pp. 4155–4172, Jan. 2023, doi: 10.1109/access.2022.3230860.

Nor Hasnida, CMG Norazilawati, A Syaza, Z. and Mahizer, H (2020). Student teachers' conception of feedback within AfL environment: Link to pupil aspiration, *Cakrawala Pendidikan*, vol. 39, no. 1, pp. 54–64, 2020.

Nor Hasnida, CMG (2016). A Reliability and Validity of an instrument to evaluate the School-Based Assessment System: a pilot study, *International Journal of Evaluation and Research in Education*, vol. 5, no. 2, p. 148, Jun. 2016, doi: 10.11591/ijere.v5i2.4533.

Orland-Barak, L. and J. Wang (2020). Teacher Mentoring in service of Preservice Teachers' Learning to Teach: Conceptual bases, characteristics, and Challenges for teacher Education reform, *Journal of Teacher Education*, vol. 72, no. 1, pp. 86–99, Jan. 2020, doi: 10.1177/0022487119894230.

Putri, S. K., Hasratuddin, and E. Syahputra (2019). Development of learning devices based on realistic mathematics education to improve students' spatial ability and motivation, *International Electronic Journal of Mathematics Education*, vol. 14, no. 2, Mar. 2019, doi: 10.29333/iejme/5729.

R. Lazarides, H. M. G. Watt, and P. Richardson (2020). Teachers' classroom management self-efficacy, perceived classroom management and teaching contexts from beginning until mid-career, *Learning and Instruction*, vol. 69, p. 101346, Oct. 2020, doi: 10.1016/j.learninstruc.2020.101346.

R. Yuwandra and I. M. Arnawa (2020). Development of learning tools based on contextual teaching and learning in fifth grade of primary schools, *Journal of Physics: Conference Series*, vol. 1554, no. 1, p. 012077, May 2020, doi: 10.1088/1742-6596/1554/1/012077.

Rohid N, S. Suryaman, and R. D. Rusmawati (2019). "Students' Mathematical Communication Skills (MCS) in Solving Mathematics Problems: A case in Indonesian context," *Anatolian Journal of Education*, vol. 4, no. 2, pp. 19–30, Sep. 2019, doi: 10.29333/aje.2019.423a.

Roubicek, Ed. (2006). *Variety of representational environments in early geometry*, vol. 1. Proceedings of the 30th Conference of International group for the Psychology of Mathematics Education, Czech Republic, 2006.

Tabachnick, M and Fidell (2007). *Using Multivariate Statistics*, 7th ed. Boston, United States of America: MA Pearson, 2014.

Tabachnick, M and Fidell. (2007). *Using Multivariate Statistics.* United States of America: Pearson Education Inc.

Tatto, Rodríguez, Reckase, Rowley, and Lu (2013). "Scale development and reporting: Opportunities to learn, beliefs, and mathematics knowledge for teaching," *TEDS*, vol. 161, 2013.

Ünal, M. (2017). "Preferences of Teaching Methods and Techniques in Mathematics with Reasons," *Universal Journal of Educational Research*, vol. 5, no. 2, pp. 194–202, Dec. 2017, doi: 10.13189/ujer.2017.050204.

Uslima, U., C. Ertikanto, and U. U. Rosidin (2018). Contextual Learning module Based on Multiple Representations: The influence on students' concept understanding, *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, vol. 3, no. 1, p. 11, Jun. 2018, doi: 10.24042/tadris.v3i1.2534.

Van Der Sandt, S. (2007) "Research Framework on Mathematics Teacher Behaviour: Koehler and Grouws' Framework revisited," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 3, no. 4, Dec. 2007, doi: 10.12973/ejmste/75413.

Wilkins, JLM (2008) "The relationship among elementary teachers' content knowledge, attitudes, beliefs, and practices," *Journal of Mathematics Teacher Education*, vol. 11, no. 2, pp. 139–164, Jan. 2008, doi: 10.1007/s10857-007-9068-2.

Yang, D and Sianturi (2020). "Analysis of algebraic problems intended for elementary graders in Finland, Indonesia, Malaysia, Singapore, and Taiwan," *Educational Studies*, vol. 48, no. 1, pp. 75–97, Mar. 2020, doi: 10.1080/03055698.2020.1740977.

Yıldırım, M and A. Güler (2020). Factor analysis of the COVID-19 Perceived Risk Scale: A preliminary study, *Death Studies*, vol. 46, no. 5, pp. 1065–1072, Jun. 2020, doi: 10.1080/07481187.2020.1784311.

Yılmaz, R. (2019). "PROSPECTIVE MATHEMATICS TEACHERS' COGNITIVE COMPETENCIES ON REALISTIC MATHEMATICS EDUCATION," *Journal on Mathematics Education*, vol. 11, no. 1, pp. 17–44, Dec. 2019, doi: 10.22342/jme.11.1.8690.17-44.

Zainudin, Hui, and Zainudin (2018). *Pendekatan Mudah SEM (Structural Equation Modelling).* Kuala Lumpur, Malaysia: MPWS Rich Resources Sdn. Bhd.

Zainudin, M. (2012). *Research Methodology and Data Analysis*. Kuala Lumpur, Malaysia: Universiti Teknologi MARA Press Malaysia.

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