Evaluating the Power of Questions: Unpacking the Validity and Reliability of a Questionnaire on Case-Based Learning and Traditional Ecological Knowledge

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Abstract. Students need meaningful learning to understand and internalize the knowledge they receive by relating what they know from their local environment with the new science concept they learn, in this study we call it Traditional Ecological Knowledge (TEK) integrated with case-based learning (CBL). However, the use of this integration needs to be measured by the correct instrument to make sure that it is measuring the correct target. Thus, this study was done to evaluate the validity and reliability of the 24-item questionnaire used in this study by using the Rasch Model analysis. The respondents were 73 students programming STEM courses and the data was collected by using a questionnaire in a Likert scale of 1 to 4. The results show that the percent agreement for each aspect is more than 90%, with the highest score in the structure of the instrument consisting of accuracy, clarity, and usefulness of the items and the overall percent agreement validity is 93.15%. Meanwhile, the validity of the instrument measured with Rasch analysis results on an acceptable validity (>20%) and the reliability of the instrument is considered as good (0.89) with the retained items as many as 12 items. The results imply that the questionnaire used in this study is valid and reliable to measure the implementation of integrated learning between case-based learning and traditional ecological knowledge.

Keywords: Rasch analysis, validity, reliability, case-based learning, traditional ecological knowledge

1 Introduction

Science is a rapidly developing knowledge that supports the advancement of technology throughout the years. However, decades ago, science was then divided into two kinds: traditional and modern science as how it was mentioned by Schumacher et al [1], and it applies in Indonesia as well. This then affects how science is taught in Indonesia, as we seek to compete globally with developed countries, we refer to American education for our standards, from the curriculum to the

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learning strategy. Here was the beginning of the misconception. We strive to be up-to-date in science education and we start to leave the traditional science behind [2]. Focusing on modern science only and considering traditional knowledge as a total misconception is a way to remove sustainable knowledge. The point is that the students need meaningful learning to understand and internalize the knowledge they receive, thus they need to relate what they know from their local environment, family, religion, or anything they got their initial knowledge before coming to the class with the new science concept they learn. Some call it indigenous science, some will call it local wisdom-based science. In this study, we call it Traditional Ecological Knowledge (TEK) as we focus on the environmental science taught in STEM courses. The topic goes around the wetland environment where the students live to get the expected meaningful learning experience, as well as training their problem-solving and decision-making skills related to wetlands problems [3].

STEM, as it is known globally as Science, Technology, Engineering, and Mathematics, is currently a challenge to implement in Indonesia as there are some misconceptions about it [4]. Thus, the Science Education Department, where this study took place, inserts it into the curriculum and programs it as a compulsory subject. In this course, students were expected to make a solution to a real-life problem and pour it into a STEM worksheet designed for secondary school students. In this case, researchers used the case-based learning (CBL) strategy to facilitate students thinking critically while analyzing cases. The cases used were contemporary and actual cases related to students' local environment that can be solved by using science knowledge. This strategy was proven able to support holistic and meaningful learning as students were trained to have complete science process skills by using real-life cases in their learning [5]. The CBL strategy used in this study follows these steps: (1) case presentation; lecturers explain cases to students, (2) students begin to analyze cases in groups, (3) group members collaborate to determine the approach to be used in solving cases, (4) formulate goals; the group determines the target of the solution to the problem to be given, (5) sorting; group members combine their initial knowledge of the environment (TEK) with what they have learned to design a problem solution project, (6) students present the results of the discussion in the form of problem solutions, and (7) students reflect on what the results and processes of the solutions provided are. This strategy was used because the CBL strategy consists of key aspects that support holistic and meaningful learning needed by students, thus researchers integrate this strategy with the TEK.

As TEK enables students to sustain their traditional knowledge and integrate it with science, it is in line with one of the sustainable development goals pillars in education: quality education, which refers to equal education that supports life-span learning [6]. Lifelong learning means "the combined knowledge acquired during the three stages of education"[7], which are primary, secondary, and tertiary school. It refers to how the knowledge we derive from every stage of education should be the base of the new knowledge receive on the next level. Therefore, the integration of TEK in STEM is essential. Sumarni et al [8] also support the implementation of Indigenous knowledge in science teaching as they stated that the integration stimulates new and meaningful learning experiences, and it is effective for implementing the STEM approach in science learning. It is then strengthened by the use of the CBL strategy to reach holistic learning while training students to think critically resulting in an ideal way of learning STEM.

According to *ScienceDirect,* since 2001, there have been around 208 studies regarding ecological knowledge in the social sciences field, but very few discussed traditional ecological knowledge in education specifically. Albeit this trend of research keeps evolving throughout the years, there is hardly a study that focuses on the TEK integrated with CBL strategy in science and or STEM learning. However, before we dive deeper into the integration of those elements, we must make sure that the instruments used to measure the implementation of the TEK-integrated CBL strategy are effective, valid, and reliable. Thus, there is a need for an analysis of the instrument's effectiveness. This study aims to analyze the questionnaire of students' perception of the integration of TEK and CBL strategy in STEM learning by using Rasch model analysis.

2 Methods

The Rasch model analysis used in this study is to measure the questionnaire regarding the implementation of the CBL strategy that integrates with TEK. This questionnaire was adapted from Jamkar et al [9] and was originally constructed of four aspects: Behavioral engagement, Cognitive engagement, Emotional engagement, and Agentic engagement. This study modified it by inserting the TEK aspect on the questionnaire, thus this questionnaire needs to be analyzed by using the Rasch model to make sure that this instrument is valid and reliable.

This questionnaire is presented on a Likert scale from 1 to 4: *(1) disagree, (2) somewhat disagree, (3) agree, and (4) strongly agree*. It consists of 24 items developed from the five aspects mentioned before and the constructs are shown in Table 1 below.

Table 1. Constructs and Items in the Questionnaire

Constructs	Number of items
Behavioral engagement	1, 2, 3, 4, 5
Cognitive engagement	6, 7, 8, 9, 10
Emotional engagement	11, 12, 13, 14, 15
Agentic engagement	16, 17, 18, 19
Traditional Ecological Knowledge	20, 21, 22, 23, 24

Before it is given to the students, this questionnaire is validated by five experts for construct validity, and then the data generated from students' answers on this questionnaire is analyzed by using SPSS software for the descriptive statistics of data and Ministep software for the item analysis. The next step is analyzing the data with 10 measurement properties of the Rasch model and it follows the properties set by Che et al [10] as seen in Table 2.

Table 2. Measurement Properties of Rasch Model Analysis

Rasch analysis	Properties	Acceptable values
Person fit	Person infit MNSQ	$0.4 < x < 1.5$
	Person infit ZSTD	$-2 < x < +2$
	Person point measure correlation	Positive value
Item fit	Item infit MNSQ	$0.4 < x < 1.5$
	Item infit ZSTD	$-2 < x < +2$
	Item point measure correlation	Positive value

Item measure	Item measure	No same value in the same construct
Standardized residual correlations	Correlation	$x < 0.7$
Dimensionality	Principal component analysis (PCA)	$x > 40\%$, unexplained first contrast of < 15%
Summary statistic	Summary statistics	Item separation Item reliability Person Reliability Person separation Cronbach's alpha

The participants of this study were 73 students programming STEM courses. Based on Wright [11], the minimum number of samples for doing the Rasch model analysis depends on the standard errors. Christensen et al [12] proposed that the adequate sample for a 24-item measure with four response categories should be 10*24*3 = 720 respondents, yet that number is hard to fulfill in this study since the number of students programming STEM courses is limited and uncontrollable. However, relevant studies by Vogel and Engelhard [13] and Lah et al [10] used small-sized samples (less than 50 respondents), and even though may be less precise, it barely affects the person-ability estimation [14]. Thus, referring to Linacre [15] who stated that Rasch model analysis requires at least six respondents for one instrument, this study used 73 respondents. The respondents were chosen by using a purposive sampling technique in which the criteria are: (1) respondents were programming STEM course, (2) respondents attended at least two case discussion sessions in STEM course, and (3) respondents have done observations in their local environment assigned by the lecturer.

3 Results and Discussion

The construct validity of this questionnaire was done by five experts chosen based on their educational specialties: two experts in STEM education, two experts in learning strategies, and one science teacher as the user expert. The items in the expert validation sheet are 30 items constructed from five aspects: content, case relevance, display, evaluation, and structure. The results are provided in Table 3 below.

Table 3. Expert Validation

No	Aspect	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Mean	Percent agreement
1	Content	3.85	4.00	3.71	3.28	3.28	3.62	90.50
2	Case relevance	3.67	3.67	3.33	4.00	3.67	3.67	91.75
3	Display	3.62	3.87	3.62	3.50	3.50	3.62	90.50
4	Outcomes	4.00	4.00	3.83	3.50	3.67	3.80	95.00
5	Structure	4.00	4.00	4.00	3.60	4.00	3.92	98.00

Based on the results in Table 3, the percent agreement for each aspect is more than 90%, with the highest score in the structure of the instrument consisting of accuracy, clarity, and usefulness of the items (98%), followed by the outcomes (comprehensiveness, items difficulties, items proportion, clear learning outcomes, and basic competence goals) by 95%. Overall, the instrument's percent agreement validity is 93.15%.

Next, we evaluate the person infit MNSQ, ZSTD, and Person point measure correlation (Pt Measure Corr) as shown in Table 4 below.

Table 4. Person infit MNSQ, ZSTD, Pt Measure Corr Summary

Criteria	Person	
	Fit	Infit
0.4 < MNSQ < 1.5 -2 < ZSTD < 2 Positive Pt Measure Corr	47	26
Percentage	64.39%	35.61%

From Table 4 we can see that 47 respondents were retained for the subsequent process as they yield the accepted range values. Then, the 47 respondents proceed to the item analysis, and the results are shown in Table 5 below.

Table 5. Item infit MNSQ, ZSTD, Pt Measure Corr Summary

Criteria	Person	
	Fit	Infit
0.4 < MNSQ < 1.5	1, 2, 3, 4, 5, 6, 7, 8, 9, 11,13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24	**10,16, 12**
-2 < ZSTD < 2	1, 2, 3, 6, 11, 15, 17, 20, 22, 23	**10, 16**, 8, 13, **12**, 24, 4, 9, 18, 19, 7, 14, 21, 5
Positive Pt Measure Corr	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12,13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24	**10**
Total	21	3
Percentage	87.5%	12.5%

Based on Sari and Mahmudi [16], items fit the measurement if they meet at least two criteria, thus the retained items were 21 items which proceed to the item measure and standardized residual correlations.

Table 6. Item Measure Value Summary

No	Construct	Item	Measure value	Infit MNSQ	Infit ZSTD	Result	Total item dropped
1	Behavioral engagement	1	0.25	0.85	-0.98	Retained	1
		2	0.23	1.07	0.43	Retained	
		3	0.26	0.96	-0.18	Retained	
		4	0.24	0.66	-2.04	Retained	
		5	0.26	1.33	2.05	Dropped	
2	Cognitive engagement	6	0.25	0.94	-0.31	Dropped	2
		7	0.25	0.66	-2.27	Retained	
		8	0.24	0.63	-2.10	Retained	
		9	0.24	0.60	-2.48	Dropped	
3	Emotional engagement	11	0.24	0.75	-1.48	Dropped	2
		13	0.24	0.62	-2.24	Retained	
		14	0.25	0.68	-2.09	Retained	
		15	0.25	0.70	-1.98	Dropped	
4	Agentic engagement	17	0.25	0.88	-0.67	Retained	1
		18	0.24	0.51	-3.22	Dropped	
		19	0.24	0.49	-3.47	Retained	
5	Traditional Ecological Knowledge	20	0.25	0.73	-1.72	Dropped	3
		21	0.25	0.69	-2.07	Retained	
		22	0.25	1.09	0.60	Dropped	
		23	0.25	1.03	0.24	Dropped	
		24	0.24	0.49	-3.27	Retained	

Item measure values as shown in Table 6 show which items out of the 21 items were retained based on the item measure value. Refering to the properties in Table 2, item measure should be in different value in the same construct, thus the result is as following: for the first construct (behavioral engagement), item 3 and 5 have the same measure value, yet item 3 has higher point measure correlation so item 3 was retained and 5 was dropped; for the second construct (cognitive engagement), item 6 and 7 have the same value, so do item 8 and 9, thus by refering to higher correlation, item 7 and 8 were retained; same case applied to emotional engagement construct where item 11 and 15 were dropped because of lower correlation compared to the items within the same measure values; on the other hand, the agentic engagement construct has only one item dropped (item 18) because it has the same value with item 19 but lower correlation; and the last one is the construct of traditional ecological knowledge with the most items dropped (3 items) because item 20, 21, 22, 23 have the same measure values, thus only one item can be retained which item 21 whose correlation is the highest. Briefly, in this step, 9 items were dropped, meaning that 12 items were retained. These 12 items were then analyzed to determine the standardized residual correlations and the results provided in Table 7 below.

Table 7. Standardized Residual Correlations

No	Criteria	No. of item
1	$x < 0.7$	1, 2, 3, 4, 7, 8,13, 14, 17, 19, 21, 24
2	$x > 0.7$	0

Table 5 shows that all the 12 items retained from the previous analysis were all retained as the values were less than 0.7. As Linacre [17] suggested, the accepted value for the standardized residual correlations was < 0.7. In this step, 12 items were retained and proceeded to the next analysis which is the unidimensionality of the instrument.

Table 8. Unidimensionality of Instrument

No		Raw variance explained by measures	Unexplained variance in first contrast
1	Before items were deleted	39.2%	7.3%
2	After items were deleted	37.7%	10.6%

The result of unidimensionality of the instrument objects to the validity of the instrument in which Fischer [18] set the standard value of >40% for the raw variance indicating a good validity. Sumintono and Widhiarso [19] also detailed this value category as acceptable (>20%), good (>40%), and excellent (>60%). However, the instrument in this study both before and after items deleted was lower than 40% but more than 20%, meaning that this questionnaire has an acceptable validity [20]. Referring to the unexplained first variance, both values were below 15% which means that the questionnaire perfectly measures the integration between case-based learning and traditional ecological knowledge [21].

Table 9. Summary Statistics

Summary statistics	Value
Item separation	1.80
Item reliability	0.76
Person reliability	0.80
Person separation	2.01
Cronbach's alpha	0.89

The Rasch analysis accurately demonstrates validity and reliability by examining how the person and item criteria interact as shown in the summary statistics [22]. Based on Table 7, we can see that the item reliability is 0.76 which indicates that it has sufficient reliability [23]. The results also show that the Cronbach's alpha is 0.89. Referring to Batchelder et al [24], the value standard for a reliable instrument is more than 0.80, while Dahlgren et al [25] confirmed that a value of at least 0.7 is considered acceptable, which means that the questionnaire used in this study is reliable.

4 Conclusion

Based on construct validity, the percent agreement for each aspect is more than 90%, with the highest score in the structure of the instrument consisting of accuracy, clarity, and usefulness of the items and the overall percent agreement validity is 93.15%. Meanwhile, the validity of the instrument measured with Rasch analysis results on an acceptable validity (>20%) and the reliability of the instrument is considered as good (0.89) with the retained items as many as 12 items. The results imply that the questionnaire used in this study is valid and reliable to measure the implementation of integrated learning between case-based learning and traditional ecological knowledge.

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References

[1] K. L. Schumacher and S. R. Gortner, "(Mis)conceptions and reconceptions about traditional science," *Advances in Nursing Science*, vol. 14, no. 4, 1992, [Online]. Available: https://journals.lww.com/advancesinnursingscience/fulltext/1992/06000/_mis_conceptions_and_reconceptioons_about.3.aspx

[2] M. Misbah *et al.*, *Is science concept can analyze by study ethnoscience? Study bibliometric and analysis*. 2024. doi: 10.1063/5.0201390.

[3] E. Susilowati, S. Miriam, S. Suyidno, A. Sholahuddin, and N. Winarno, "Integration of Learning Science, Technology, Engineering, and Mathematics (STEM) in The Wetland Environment Area to Increase Students' Creativity," *J. Phys.: Conf. Ser.*, vol. 1491, no. 1, p. 012047, Mar. 2020, doi: 10.1088/1742-6596/1491/1/012047.

[4] A. Prahatama Putra, S. Suyidno, N. Hidayati Utami, F. Fahmi, and B. Kurnia Prahani, "Development of STEM Learning Based on Riverbanks Local Wisdom," *E3S Web Conf.*, vol. 400, p. 02001, 2023, doi: 10.1051/e3sconf/202340002001.

[5] A. Sholahuddin *et al.*, "Using a Cognitive Style-Based Learning Strategy to Improve Students' Environmental Knowledge and Scientific Literacy," *INT J INSTRUCTION*, vol. 14, no. 4, pp. 791–808, Oct. 2021, doi: 10.29333/iji.2021.14445a.

[6] R. Maryanti *et al.*, “SUSTAINABLE DEVELOPMENT GOALS (SDGS) IN SCIENCE EDUCATION: DEFINITION, LITERATURE REVIEW, AND BIBLIOMETRIC ANALYSIS,” no. 6.

[7] V. S. Tchamyou, “Education, lifelong learning, inequality and financial access: evidence from African countries,” *Contemporary Social Science*, vol. 15, no. 1, pp. 7–25, Jan. 2020, doi: 10.1080/21582041.2018.1433314.

[8] W. Sumarni, S. Darmin, S. Sumarti, and S. Kadarwati, “Indigenous knowledge of Indonesian traditional medicines in science teaching and learning using a science–technology–engineering–mathematics (STEM) approach,” *Cultural Studies of Science Education*, vol. 17, Jun. 2022, doi: 10.1007/s11422-021-10067-3.

[9] A. V. Jamkar, W. Burdick, P. Morahan, V. Y. Yemul, Sarmukadum, and G. Singh, “Proposed model of case based learning for training undergraduate medical student in surgery,” *Indian J Surg*, vol. 69, no. 5, pp. 176–183, Oct. 2007, doi: 10.1007/s12262-007-0016-2.

[10] N. H. Che Lah, Z. Tasir, and N. F. Jumaat, “An Evaluation of the Online Social Learning Environment Instrument (OSLEI) Using Rasch Model Analysis,” *SAGE Open*, vol. 12, no. 2, p. 215824402211040, Apr. 2022, doi: 10.1177/21582440221104083.

[11] B. D. Wright, “MISUNDERSTANDING THE RASCH MODEL,” *J Educational Measurement*, vol. 14, no. 3, pp. 219–225, Sep. 1977, doi: 10.1111/j.1745-3984.1977.tb00039.x.

[12] K. S. Christensen, F. Cosci, D. Carrozzino, and T. Sensky, “Rasch Analysis and Its Relevance to Psychosomatic Medicine,” *Psychother Psychosom*, vol. 93, no. 2, pp. 88–93, 2024, doi: 10.1159/000535633.

[13] S. P. Vogel and G. Engelhard Jr., “Using Rasch Measurement Theory to Examine Two Instructional Approaches for Teaching and Learning of French Grammar,” *The Journal of Educational Research*, vol. 104, no. 4, pp. 267–282, Jun. 2011, doi: 10.1080/00220671003733815.

[14] T. R. O’Neill, J. L. Gregg, and M. R. Peabody, “Effect of Sample Size on Common Item Equating Using the Dichotomous Rasch Model,” *Applied Measurement in Education*, vol. 33, no. 1, pp. 10–23, Jan. 2020, doi: 10.1080/08957347.2019.1674309.

[15] J. M. Linacre, “Sample size and item calibration stability. Rasch Measurement Transactions, 7 (4), 328,” *Extrait de http://www. rasch. org/rmt/rmt74m. htm*, 1994, Accessed: Oct. 29, 2024. [Online]. Available: https://scholar.google.com/scholar?cluster=4329562254140254338&hl=en&oi=scholarr

[16] E. D. K. Sari and I. Mahmudi, *ANALISIS PEMODELAN RASCH PADA ASESMEN PENDIDIKAN*. PT. Pena Persada Kerta Utama, 2024. Accessed: Oct. 30, 2024. [Online]. Available: https://www.researchgate.net/publication/378210331_BUKU_ANALISIS_PEMODELAN_RASCH_PADA_ASESMEN_PENDIDIKAN

[17] J. Linacre, “Understanding Rasch measurement: Optimizing rating scale category effectiveness,” *Journal of applied measurement*, vol. 3, pp. 85–106, Feb. 2002.

[18] G. H. Fischer, “16 Rasch Models,” in *Handbook of Statistics*, vol. 26, C. R. Rao and S. Sinharay, Eds., in Psychometrics, vol. 26. , Elsevier, 2006, pp. 515–585. doi: 10.1016/S0169-7161(06)26016-4.

[19] B. Sumintono and W. Widhiarso, *Aplikasi pemodelan rasch pada assessment pendidikan*. Trim komunikata, 2015. Accessed: Nov. 09, 2024. [Online]. Available: http://eprints.um.edu.my/14228/

[20] J. Ahmad and N. M. Siew, “CURIOSITY TOWARDS STEM EDUCATION: A QUESTIONNAIRE FOR PRIMARY SCHOOL STUDENTS,” *Journal of Baltic Science Education*, vol. 20, pp. 289–304, Apr. 2021, doi: 10.33225/jbse/21.20.289.

[21] D. Indihadi, D. Suryana, and A. B. Ahmad, “THE ANALYSIS OF CONSTRUCT VALIDITY OF INDONESIAN CREATIVITY SCALE USING RASCH MODEL,” *Creativity Studies*, vol. 15, no. 2, pp. 560–576, Aug. 2022, doi: 10.3846/cs.2022.15182.

[22] H. Hairida *et al.*, “Evaluating Digital Literacy of Pre-service Chemistry Teachers: Multidimensional Rasch Analysis,” *Journal of Science Education and Technology*, vol. 32, pp. 1–12, Aug. 2023, doi: 10.1007/s10956-023-10070-z.

[23] S. Mahtari, H. Nadieya, S. Suyidno, and B. K. Prahani, “The using the Rasch model to analyze the test of scientific literacy of impulse and momentum material,” in *AIP Conference Proceedings*, AIP Publishing, 2024. Accessed: Nov. 09, 2024. [Online]. Available: https://pubs.aip.org/aip/acp/article-abstract/3058/1/020022/3280993

[24] L. Batchelder *et al.*, “Rasch analysis of the long-term conditions questionnaire (LTCQ) and development of a short-form (LTCQ-8),” *Health Qual Life Outcomes*, vol. 18, no. 1, p. 375, Nov. 2020, doi: 10.1186/s12955-020-01626-3.

[25] A. Dahlgren *et al.*, “Critical thinking about treatment effects in Eastern Africa: development and Rasch analysis of an assessment tool,” *F1000Res*, vol. 12, p. 887, Jul. 2023, doi: 10.12688/f1000research.132052.1.