**Nazhruna**: Jurnal Pendidikan Islam
Vol. 7 Issue 2, 2024. pp. 475-492 E-ISSN: 2614-8013
DOI: https://doi.org/10.31538/nzh.v7i2.4425

# Construction of Mathematics Cognitive Test Instrument of Computational Thinking Model for Madrasah Aliyah Students

**Muhammad Istiqlal✉[1], Edi Istiyono[2], Widihastuti[3], Desy Kumala Sari[4], Rahmat Danni[5], Islamiani Safitri[6]**
Universitas Negeri Yogyakarta, Indonesia[1,2,3,4,5,6]
Email correspondence: muhammad.istiqlal2023@student.uny.ac.id

Received: 10-12-2023 Revised: 23-05-2024 Accepted: 23-07-2024

**Abstract**

Mathematical knowledge and computational thinking train students' ability to reason, and this is needed to be able to compete in the digital era in the future. This study aims to construct a mathematical cognitive test instrument using the computational thinking (CT) model that meets the validity, reliability, and good item criteria and provides new insights into how to apply computational thinking in Islamic education (madrasah). This research includes development research consisting of design and implementation stages with a sample of 160 madrasah aliyah students in the Sleman district. Instrument validity was conducted by proving content validity. Reliability was estimated using the separation reliability coefficient, and the quality of the instrument was analyzed using the Rasch model. The instrument was declared reliable (separation reliability coefficient of 0.8059), classified as a good fit for the model, with a p-value of 0.64 > 0.05), and effective in measuring mathematics skills with a percentage of 99.85%. The instrument developed opens the insight that the subject matter in madrasah can be integrated with computational thinking skills and can be used as an alternative for diagnostic, formative, and summative tests.

**Keywords**: Instrument Construction, Computational Thinking Skills, Mathematics Cognitive Test, Madrasah Aliyah.

***Abstrak***

*Pengetahuan Matematika dan Berpikir komputasi melatih kemampuan siswa dalam menalar, dan ini sangat dibutuhkan untuk bisa bersaing di era digital di masa yang akan datang. Penelitian ini bertujuan untuk mengkonstruksi instrumen tes kognitif matematis menggunakan model computational thinking (CT) yang memenuhi validitas, reliabilitas, dan kriteria butir soal yang baik serta memberikan wawasan baru tentang bagaimana menerapkan pemikiran komputasi di dalam pendidikan islam (madrasah). Penelitian ini termasuk penelitian pengembangan yang terdiri dari tahap perancangan dan pelaksanaan dengan sample 160 siswa madrasah aliyah di kabupaten Sleman. Validitas instrumen dilakukan dengan membuktikan validitas konten. Reliabilitas diestimasi menggunakan koefisien separation reliability, dan kualitas instrumen dianalisis dengan model Rasch. Instrumen dinyatakan reliabel (koefisien separation reliability sebesar 0,8059), tergolong cukup baik (good fit of model, p-value sebesar 0,64 > 0,05), dan efektif mengukur kemampuan matematika dengan persentase 99,85%. Instrumen yang dikembangkan membuka wawasan bahwa materi pelajaran di madrasah sangat memungkinkan untuk diintegrasikan dengan kemampuan berpikir komputasi, dan dapat digunakan sebagai alternatif untuk tes diagnostik, formatif, maupun sumatif.*

***Kata Kunci***: *Konstruksi Instrumen, Keterampilan Berpikir Komputasi, Tes Kognitif Matematika, Madarsah Aliyah.*

## INTRODUCTION

The digital age requires everyone to be able to think positively and act quickly. Computational thinking (CT) skills are increasingly vital in meeting these challenges.[1] CT involves problem-solving, system design, and understanding human behavior by utilizing basic computer science concepts.[2] In the context of a complex and globally connected society, CT is key to addressing complex and multifaceted problems. This ability helps students to develop problem-solving skills.[3] Computational thinking skills have been promoted in schools around the world.[4] Moreover, in developed countries, computational thinking has been integrated into the school education curriculum, such as America, which in 2016 initiated Computer Science for All.[5] Asian countries such as Korea, Taiwan, Hong Kong, and China have also reformed the national curriculum by integrating CT education into K-12 education.[6] However, teachers' opportunities to develop students' computational thinking skills are still limited, schools need to help teachers integrate them into learning practices. Computational thinking skills enable students to become more skilled in using digital tools, understanding the basics of programming, and solving technical problems.[7] CT allows students to master digital technology, programming basics, and solving techniques, which are essential in solving complex problems efficiently.

Recent research explores integrating CT and Islamic values in mathematics education. Studies show that incorporating Islamic values in mathematics learning can enhance character development, instill virtues like honesty and discipline, and align with Islamic school principles.[8]

---

[1] Yasemin Allsop, "Assessing Computational Thinking Process Using a Multiple Evaluation Approach," *International Journal of Child-Computer Interaction* 19 (Maret 2019): 30–55, https://doi.org/10.1016/j.ijcci.2018.10.004; Pujia Siti Balkist dan Dadang Juandi, "Trend of critical thinking skill studies in mathematics education: A study design to data analysis," *International Journal of Trends in Mathematics Education Research* (SAINTIS Publishing, 2022), https://doi.org/10.33122/ijtmer.v5i4.166.

[2] Rachel F. Adler dan Hanna Kim, "Enhancing Future K-8 Teachers' Computational Thinking Skills through Modeling and Simulations," *Education and Information Technologies* 23, no. 4 (Juli 2018): 1501–14, https://doi.org/10.1007/s10639-017-9675-1; Valentina Dagienė dan Sue Sentance, "It's Computational Thinking! Bebras Tasks in the Curriculum," dalam *Informatics in Schools: Improvement of Informatics Knowledge and Perception*, ed. oleh Andrej Brodnik dan Françoise Tort, vol. 9973, Lecture Notes in Computer Science (Cham: Springer International Publishing, 2016), 28–39, https://doi.org/10.1007/978-3-319-46747-4_3.

[3] Charoula Angeli dan Michail Giannakos, "Computational Thinking Education: Issues and Challenges," *Computers in Human Behavior* 105 (April 2020): 106185, https://doi.org/10.1016/j.chb.2019.106185; Golnaz Arastoopour Irgens dkk., "Modeling and Measuring High School Students' Computational Thinking Practices in Science," *Journal of Science Education and Technology* 29, no. 1 (Februari 2020): 137–61, https://doi.org/10.1007/s10956-020-09811-1.

[4] Jesús Moreno-León dkk., "On the Automatic Assessment of Computational Thinking Skills: A Comparison with Human Experts," dalam *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (CHI '17: CHI Conference on Human Factors in Computing Systems, Denver Colorado USA: ACM, 2017), 2788–95, https://doi.org/10.1145/3027063.3053216.

[5] Enrico Nardelli, "Do We Really Need Computational Thinking?," *Communications of the ACM* 62, no. 2 (28 Januari 2019): 32–35, https://doi.org/10.1145/3231587.

[6] Hyo-Jeong So, Morris Siu-Yung Jong, dan Chen-Chung Liu, "Computational Thinking Education in the Asian Pacific Region," *The Asia-Pacific Education Researcher* 29, no. 1 (Februari 2020): 1–8, https://doi.org/10.1007/s40299-019-00494-w.

[7] Satabdi Basu dkk., "Identifying Middle School Students' Challenges in Computational Thinking-Based Science Learning," *Research and Practice in Technology Enhanced Learning* 11, no. 1 (Desember 2016): 13, https://doi.org/10.1186/s41039-016-0036-2; Ugur Kale dkk., "Computational What? Relating Computational Thinking to Teaching," *TechTrends* 62, no. 6 (November 2018): 574–84, https://doi.org/10.1007/s11528-018-0290-9.

[8] Indri Mahmudah dan Muqowim Muqowim, "Integration Of Islamic Values In Mathematics Learning In Class IV Stud ents Of Madrasah Ibtidaiyah," *Al-Madrasah: Jurnal Pendidikan Madrasah Ibtidaiyah*, 2022; Kusno Kusno,

The integration of CT in mathematics education is gaining attention, with studies highlighting its potential to support mathematical understanding and problem-solving skills.[9] From an Islamic perspective, computational thinking encompasses ethical and moral dimensions, necessitating the integration of Islamic values in the development of computational thinking tools in mathematics to ensure they measure not only cognitive aspects but also foster students' character according to Islamic principles. Several researchers have developed rating scales for CT, such as the scale developed by Román-González et al. Other studies have also successfully developed assessments for critical thinking skills.[10] However, it is still rare to find research that focuses on developing tools to assess computative thinking skills in an integrated manner, especially in the field of mathematics learning. Modern mathematics today is closely related to computing and technology. In addition to critical thinking skills, computational skills allow students to use tools such as software, and other mathematical tools. Mathematics is not just about understanding concepts and calculations, but involves complex problem solving, in-depth analysis, and application in real-life contexts.[11] When it comes to solving complex mathematical problems, students require rigorous thinking and in-depth analysis.[12] Critical thinking skills can help students in understanding the problem, formulating a solution strategy, and analysing the results obtained. Meanwhile, computational thinking skills help students translate problem solving into simple solution steps that can be translated into a computer system.

In PISA 2021, the measurement of CT aspects is included in the field of mathematics assessment.[13] However, the challenge in integrating CT into formal education is more than just

---

M. Marsigit, dan M. Yaakob, "Integration of islamic spiritual values with mathematics teaching," 2020; Muhamad Imaduddin dkk., "Exploring the Pre-Service Basic Science Teachers' Misconceptions Using the Six-Tier Diagnostic Test," *International Journal of Evaluation and Research in Education (IJERE)* 12, no. 3 (1 September 2023): 1626, https://doi.org/10.11591/ijere.v12i3.24603.

[9] Arnulfo Perez, "A Framework for Computational Thinking Dispositions in Mathematics Edu cation," *Journal for Research in Mathematics Education*, 2018; Huiyan Ye dkk., "Integration of computational thinking in K-12 mathematics education: a systematic review on CT-based mathematics instruction and student learning," *International Journal of STEM Education* (Springer Science and Business Media LLC, 2023), https://doi.org/10.1186/s40594-023-00396-w.

[10] Ayu Faradillah dan Sabila Adlina, "Validity of critical thinking skills instrument on prospective Mathematics teachers," *Jurnal Penelitian dan Evaluasi Pendidikan* (Universitas Negeri Yogyakarta, 2021), https://doi.org/10.21831/pep.v25i2.40662; B. Harjo, "Development of critical thinking skill instruments on mathematical learning high school," *International Journal of Instruction*, 2019, https://doi.org/10.29333/iji.2019.12410a; Y. Romadiastri, "Mathematical critical thinking ability: The effect of scale difference on integral," *IOP Conference Series: Earth and Environmental Science*, 2021, https://doi.org/10.1088/1742-6596/1796/1/012120.

[11] Tita Mulyati dkk., "Effect of Integrating Children's Literature and SQRQCQ Problem Solving Learning on Elementary School Student's Mathematical Reading Comprehension Skill," *International Electronic Journal of Mathematics Education* 12, no. 3 (29 Mei 2017): 217–32, https://doi.org/10.29333/iejme/610; Özcan ÖZYURT, "Examining the Critical Thinking Dispositions and the Problem Solving Skills of Computer Engineering Students," *EURASIA Journal of Mathematics, Science and Technology Education* (Modestum Publishing Ltd, 2015), https://doi.org/10.12973/eurasia.2015.1342a; Zsuzsanna Katalin Szabo dkk., "Examples of Problem-Solving Strategies in Mathematics Education Supporting the Sustainability of 21st-Century Skills," *Sustainability* 12, no. 23 (3 Desember 2020): 10113, https://doi.org/10.3390/su122310113.

[12] Ekasatya Aldila Afriansyah dkk., "Critical thinking skills in mathematics," *Journal of Physics: Conference Series* (IOP Publishing, 2021), https://doi.org/10.1088/1742-6596/1778/1/012013; Nur Rohmatul Aini dkk., "Problem Based Learning for Mathematics Critical Thinking Skills" (Center for Open Science, 2018), https://doi.org/10.31219/osf.io/968pg.

[13] Muhammad Zuhair Zahid, "Telaah kerangka kerja PISA 2021: era integrasi computational thinking dalam bidang matematika" 3 (2020).

learning computing concepts. How to assess computing concepts, attitudes and practices also remains a challenge. The need for assessment of critical thinking and computational skills is crucial in today's digital era.[14] It helps individuals face complex challenges, filter information, and utilise technology wisely. In Indonesia, the Merdeka Curriculum has paid attention to computational thinking by integrating it in the subjects of Indonesian Language, Mathematics, and Natural and Social Sciences (IPAS) since Primary School. CT integration becomes essential in the independent curriculum at the elementary level (Kemdikbud, 2022).

This research aims to develop a cognitive test instrument based on the computational thinking model in the context of mathematics learning. The instrument being developed is expected to be an effective alternative to evaluate students' computational thinking ability in mathematics learning, either in the form of formative, summative, or diagnostic tests. In addition, this research also seeks to see the importance of developing CT instruments from an Islamic perspective to support madrasah students' mathematics learning. The focus of this research is the development of an instrument that can be used by Madrasah Aliyah students, considering that madrasah students also have the potential to compete and achieve at the same level as students in other senior high schools.[15] It is hoped that the results of this study will not only contribute to the development of computational thinking evaluation, but will also open new insights into the interrelationship between computational thinking and Islamic education in madrasah education environment.

This research aims to develop an instrument for measuring computational thinking ability that is adjusted to the characteristics of students in Islamic educational institutions (madrasah). The developed instrument can be used by madrasah or teachers to diagnose the computational thinking ability of madrasah students, which can then be used as a basis for designing mathematics learning following the computational thinking level of madrasah students. The computational thinking instrument under development will undergo a series of validity and reliability tests before it is used to measure madrasah students' computational thinking ability. The test steps include checking the consistency and reliability of the instrument as well as assessing the extent to which the instrument accurately reflects students' computational thinking ability.[16] After the validation and reliability process is completed, the instrument will be applied in a madrasah environment to evaluate students' computational thinking ability effectively and objectively. It is hoped that the use of this instrument will provide

[14] Francesc M. Esteve-Mon, M. Ángeles Llopis, dan Jordi Adell-Segura, "Digital Competence and Computational Thinking of Student Teachers," *International Journal of Emerging Technologies in Learning (iJET)* 15, no. 02 (29 Januari 2020): 29, https://doi.org/10.3991/ijet.v15i02.11588; Sarah Gretter dan Aman Yadav, "Computational Thinking and Media & Information Literacy: An Integrated Approach to Teaching Twenty-First Century Skills," *TechTrends* 60, no. 5 (September 2016): 510–16, https://doi.org/10.1007/s11528-016-0098-4.

[15] Ubair Anjum, "Assessing the Need of Modern Education in Madrassah System: A Case Study of Madaris in Lahore," *Arts and Social Sciences Journal* 08, no. 04 (2017), https://doi.org/10.4172/2151-6200.1000286; Imron Rosyadi, Andika Aprilianto, dan Muhammad Husnur Rofiq, "Development of Islamic Educational Institutions in Increasing Competitiveness in Madrasah Tsanawiyah," *Chalim Journal of Teaching and Learning* 3, no. 1 (18 September 2023): 52–63, https://doi.org/10.31538/cjotl.v3i1.723; Jakfar Sodik, "STRATEGY FOR INCREASING THE COMPETITIVENESS OF MADRASAH" 1, no. 1 (2023).

[16] Siti Rahayah Ariffin dkk., "Validity and Reliability Multiple Intelligent Item Using Rasch Measurement Model," *Procedia - Social and Behavioral Sciences* 9 (2010): 729–33, https://doi.org/10.1016/j.sbspro.2010.12.225; Norasmah Binti Othman, Suria Mohd Salleh, dan Haliza Hussein, "Assessing Construct Validity And Reliability Of Competitiveness Scale Using Rasch Model Approach," 2014.

a deeper understanding of the level of students' computational thinking ability, as well as a foundation for curriculum development and learning strategies that better suit their needs in facing the challenges in today's digital era.

## METHOD

### *Research design*

This study aims to construct a mathematical cognitive test instrument with a computational thinking model that is valid, reliable, and has quality items. The developed instrument is used in formative tests in mathematics learning at Madrasah Aliyah. This research is a development research using a modified model of Borg & Gall and Plomp.[17] The modified model consists of the design stage (compiling test specifications, writing test questions, reviewing and correcting test questions, compiling assessment guidelines, and determining completeness criteria) and the implementation stage (testing test instruments, analyzing items, determining the quality of items, and describing test results).

### *Population and Sample*

The sample of this study was madrasah students in Sleman and Magelang districts totaling 160 students. The sample was selected randomly by volunteering to fill in the computational thinking instrument. Grade 12 students participated in the research with 67 (42%) males and 93 (58%) females with an average age of 15.52.

### *Data Analysis Techniques*

The instrument will be validated and its reliability measured, as well as looking at the quality of the items. The validity that will be proven is content validity and construct validity. Content validity is proven by the assessment of 7 experts in measurement and mathematics learning by looking at the V-Aiken value. Construct validity is proven by Exploratory Factor Analysis (EFA) to prove whether the instrument is unidimensional or not. Instrument reliability was measured using the Separation Reliability Coefficient in the Rasch model. Then, the quality of the items will be analyzed using the Item Response Theory 1 PL Logistic Model often referred to as the Rasch Model. Rasch model analysis was conducted with the help of the R program. In the analysis, the model fit, Item Difficulty Level, Item Characteristic Curve, Item Information Curve, Test Information Curve, and Test Information will be calculated.

## RESULTS AND DISCUSSION

### Validity

Instrument validity is proven by content validity.[18] Seven experts validated the content. Content validity was quantitatively analyzed using Aiken's formula. The instrument developed is feasible to be used to measure mathematics cognitive tests with CT model in mathematics learning, instrument indicators are described in Table 1. Details of the content validity values are presented in Table 2. Furthermore, based on the content validity both qualitatively and quantitatively, the instrument was tested.

---

[17] Tjeerd Plomp, "Educational design research: An introduction," *Educational design research*, 2013, 11–50.

[18] Supahar Widihastut, Syukrul Hamdi, dan Edi Istiyono, "Measuring Creative Thinking Skills of Senior High School Male and Female Students in Physics (CTSP)Using the IRT-Based PhysTCreTS," *Turkish Journal of Science Education* 17, no. 4 (21 Juli 2020): 578–90, https://doi.org/10.36681/tused.2020.46.

**Table 1**. Indicators of questions on the instrument

| Number | Indicators |
|---|---|
| 1 | Explain the concept of elements in a matrix |
| 2 | Explain the concept of rows and columns in a matrix |
| 3 | Constructing a matrix arrangement |
| 4 | Explaining the similarity of two matrices |
| 5 | Explain the concept of addition and subtraction operations in matrices |
| 6 | Explain the concept of transpose in matrices |
| 7 | Use addition and subtraction operation procedures on matrices to solve contextual problems |
| 8 | Using matrix multiplication operation procedures to solve contextual problems |
| 9 | Using row and column concepts to solve contextual problems |
| 10 | Use matrix multiplication operation procedures to solve contextual problems |
| 11 | Explain the properties of the determinant and inverse of a 2x2 matrix |
| 12 | Use procedures to solve contextual problems related to matrix determinant and inverse of 2×2 matrix. |

**Table 2.** Content Validity using the V-Aiken index

| Item | Aspect of Materials | | Aspect of Construction | | Aspects of Language | |
|---|---|---|---|---|---|---|
| | Value | Category | Value | Category | Value | Category |
| 1 | 0,889 | High | 0,778 | Medium | 0,778 | Medium |
| 2 | 0,889 | High | 0,889 | High | 0,778 | Medium |
| 3 | 0,889 | High | 0,778 | Medium | 0,889 | High |
| 4 | 0,778 | Medium | 0,778 | Medium | 0,778 | Medium |
| 5 | 0,889 | High | 0,889 | High | 0,667 | Medium |
| 6 | 0,778 | Medium | 0,667 | Medium | 0,889 | High |
| 7 | 0,778 | Medium | 0,778 | Medium | 0,889 | High |
| 8 | 0,889 | High | 0,889 | High | 0,778 | Medium |
| 9 | 0,889 | High | 0,778 | Medium | 0,889 | High |
| 10 | 0,889 | High | 0,889 | High | 0,778 | Medium |
| 11 | 0,778 | Medium | 0,667 | Medium | 0,889 | High |
| 12 | 0,889 | High | 0,778 | Medium | 0,778 | Medium |

### Test Assumptions of Item Response Theory

Factor analysis was used to prove the assumption of unidimensionality in the developed test instrument. This analysis is used to see the eigenvalue of the inter-item covariance matrix. Sample adequacy analysis was conducted first before conducting data analysis using factor analysis.

Based on the analysis of sample adequacy, it shows that the Khi-squared value in the Bartlet test is 922.176 with 66 degrees of freedom and a p-value of less than 0.01. These results indicate that the sample size of 160 used in this study is sufficient. The Bartlet test results are presented in Table 3.

Table 3. Bartlett's Test

| $X^2$ | Df | P |
|---|---|---|
| 922.176 | 66.000 | < .001 |

The results of the factor analysis of the CT model mathematical cognitive test instrument show that three factors have an eigenvalue of more than 1. The eigenvalue is presented using the Scree Plot (Figure 1). It can be seen that the eigenvalue starts to slope on the 2nd factor. Thus, it can be ascertained that there is 1 dominant factor in the cognitive test instrument developed. This indicates that the cognitive test instrument measures 1 ability, namely the cognitive ability of students' mathematics.

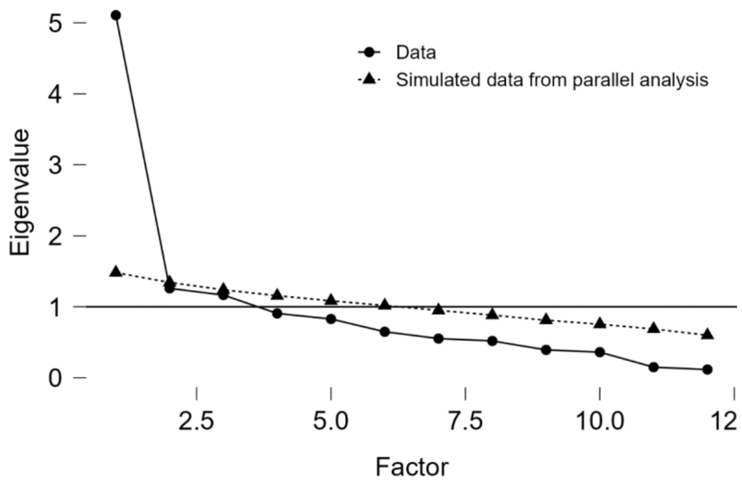



**Figure 1**. Screeplot of CT model Cognitive Test Instrument

**Item Fit**

If the p-value is <0.05, the item does not fit the Rasch model. Conversely, if the p-value > 0.05, then the item fits the Rasch model. It was found that item 8 and item 10 did not fit the Rasch model because the p-value was <0.05. Thus, 10 items were obtained that fit the Rasch model.

Itemfit Statistics:

| | Chisq | df | p-value | Outfit MSQ | Infit MSQ | Outfit t | Infit t | Discrim |
|---|---|---|---|---|---|---|---|---|
| item1 | 69.106 | 137 | 1.000 | 0.501 | 0.734 | -2.166 | -2.220 | 0.744 |
| item2 | 41.538 | 137 | 1.000 | 0.301 | 0.473 | -1.880 | -5.048 | 0.659 |
| item3 | 85.877 | 137 | 1.000 | 0.622 | 0.828 | -1.702 | -1.567 | 0.715 |
| item4 | 164.957 | 137 | 0.052 | 1.195 | 1.130 | 0.763 | 1.002 | 0.535 |
| item5 | 120.147 | 137 | 0.847 | 0.871 | 0.942 | 0.212 | -0.287 | 0.319 |
| item6 | 64.966 | 137 | 1.000 | 0.471 | 0.707 | -1.172 | -2.460 | 0.591 |
| item7 | 95.137 | 137 | 0.997 | 0.689 | 0.837 | -1.258 | -1.358 | 0.701 |
| item8 | 248.509 | 137 | 0.000 | 1.801 | 1.548 | 1.191 | 3.164 | 0.211 |
| item9 | 144.705 | 137 | 0.310 | 1.049 | 1.471 | 0.271 | 3.128 | 0.264 |
| item10 | 222.893 | 137 | 0.000 | 1.615 | 1.357 | 0.894 | 2.128 | 0.199 |
| item11 | 134.009 | 137 | 0.556 | 0.971 | 0.835 | -0.003 | -1.232 | 0.683 |
| item12 | 33.291 | 137 | 1.000 | 0.241 | 0.379 | -2.919 | -5.336 | 0.889 |

**Figure 2**. Itemfit Output

**Independent Local Test**

In the local independence test, the p-value (0.232) > 0.05 is obtained, so it is said that there has been a violation of the local independent assumption but there is no disturbing unidimensionality.

## Separation Reliability

Instrument reliability is measured by the Separation Reliability coefficient. The reliability of the instrument is 0.8059, meaning that the instrument has good reliability.

## Rasch Model

At the initial stage of analysis using the Rasch model, the level of item difficulty was analyzed. The level of difficulty of items is the same as the z value commonly used in normal curve calculations, the level of difficulty is in the interval -2 to 2. Based on the output of the Rasch model analysis related to the level of difficulty of the question, it shows that item 5 has the lowest level of difficulty (-1.841) compared to other items. The most difficult item is item 9 (0.589). The difficulty level of each item is presented in Figure 3.

```
Coefficients:
 Dffclt.item1   Dffclt.item2   Dffclt.item3   Dffclt.item4
       -0.623          0.479         -0.444         -0.622
 Dffclt.item5   Dffclt.item6   Dffclt.item7   Dffclt.item8
       -1.841          0.501         -0.554         -1.421
 Dffclt.item9  Dffclt.item10  Dffclt.item11  Dffclt.item12
        0.589         -1.652         -0.693         -0.916
       Dscrmn
        2.315

Log.Lik: -798.76
```

Figure 3. Problem difficulty level

Next, the model fit will be calculated (Figure 4), the results show that the p-value = 0.64 is greater than 0.05, meaning that the cognitive test instrument model is good enough (good fit of model).

```
Bootstrap Goodness-of-Fit using Pearson chi-squared

Call:
rasch(data = databersih, IRT.param = TRUE)

Tobs: 1766.64
# data-sets: 50
p-value: 0.64
```

Figure 4. Model fit

Another thing to note is the Item Difficulty Level. If the item difficulty is equal to 0, it means that the item difficulty level is the average on the test. If the item difficulty is greater than 0, it means that the item difficulty level is above average. For example, the item difficulty of item 5 is -.1840, so it is considered an easy or below average item because its value is below 0, while item 9 is considered a difficult or above average item because its value is above 0, namely 0.588. Data related to item difficulty level on each item is presented in Figure 5.

```
> coef(model,prob = TRUE,order = TRUE)
          Dffclt   Dscrmn P(x=1|z=0)
item5  -1.8407482 2.315327  0.9861009
item10 -1.6518837 2.315327  0.9786402
item8  -1.4208746 2.315327  0.9640769
item12 -0.9156603 2.315327  0.8928370
item11 -0.6925322 2.315327  0.8324984
item1  -0.6226467 2.315327  0.8087071
item4  -0.6224973 2.315327  0.8086536
item7  -0.5542522 2.315327  0.7830068
item3  -0.4439123 2.315327  0.7364896
item2   0.4793731 2.315327  0.2478885
item6   0.5009392 2.315327  0.2386967
item9   0.5887831 2.315327  0.2037166
```

Figure 5. Item Difficulty Level

Next we look at the Item Characteristic Curve. The item characteristic curve is shown using the ICC with the help of the R programme. Based on the analysis results using the R programme, the item characteristic curve is obtained for each item. Figure 6 shows the ICC for all items (12 items), while Figure 3 shows an example of the ICC for non-major item 9. In the ICC graph, the x-axis is the ability level and the y-axis is the chance of doing the item correctly. The further to the right the difficulty level of the item is, the higher it is.

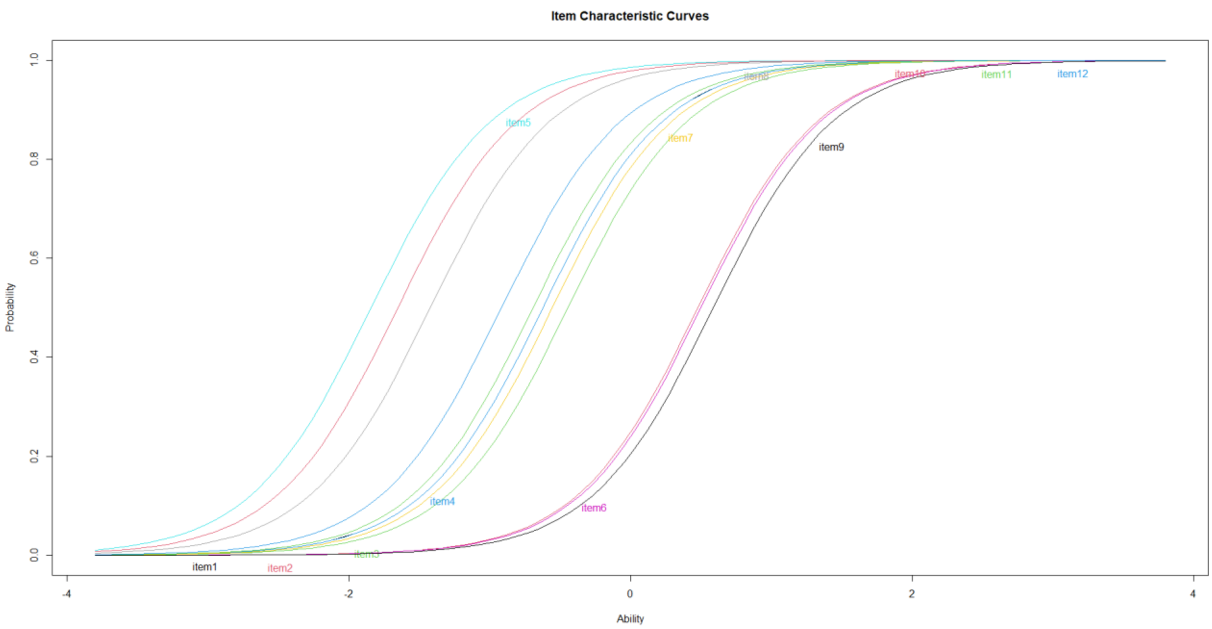



Figure 6. ICC for all items

To see the difficulty level of the item, we imagine that there is a line at 50% probability on the slope. For example, in item 9 (figure 7), if we point to the Y-axis (probability) at 0.5, it will intersect with the curve, then pulled down to get the ablitity value. In the case of itemp 9, when the probability is 50%, the ability will be obtained 1.3.

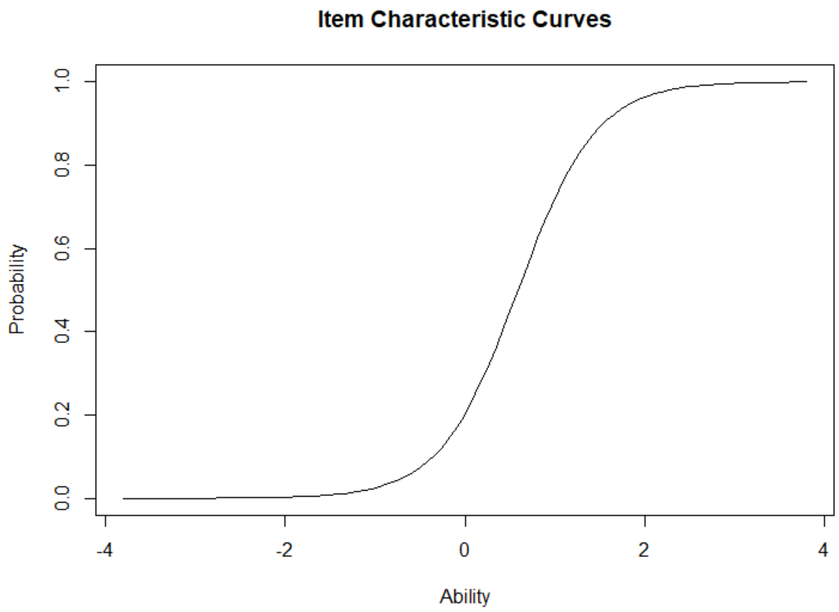



Figure 7. ICC for item number 9

Every measurement should be able to present information about the measurement results. The information in question is not information about individual respondents but information about question items. Information about question items relates to questions and the results of student responses to these questions (Mardapi, 2016). The information obtained is very dependent on the variation in the measurement results, namely student responses. So that more respondents will provide real variation in the results of measuring items. Figure 8 shows the item information function. The x-axis shows the level of student ability made on a scale of -4 to 4, where -4 is a very low ability and 4 is a very high ability. The y-axis shows the magnitude of the information function obtained from the measurement results with 12 items. Figure 8 shows the IIC graphs for item 5 and item 9 (figure 9).

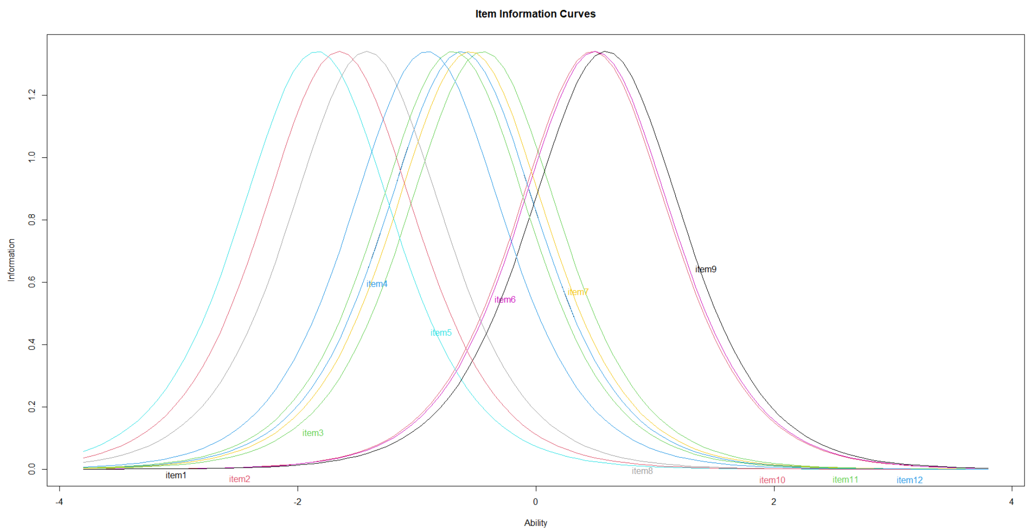



Figure 8. Item Information Curves

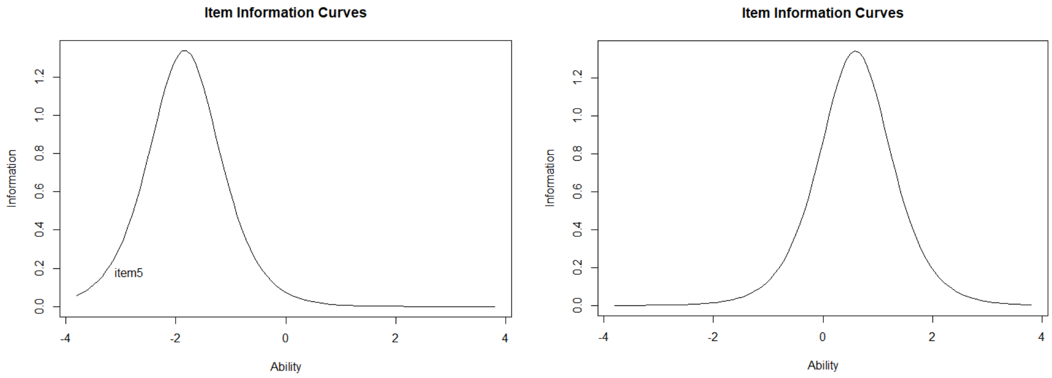
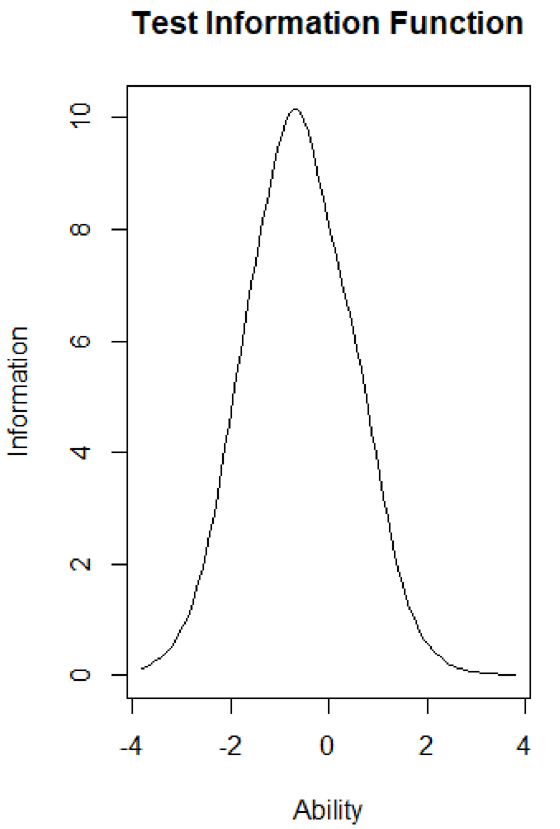



Figure 9. IIC Item 5 & Item 9

The test instrument was able to measure latent ability by 99.85%. This shows that the 12 items effectively measure latent ability. The TIF curve shows that this test will be effective if given to students with average ability, while if given to students with low ability it will not be optimal, and also if given to students with high ability it will also not be optimal.




```
Call:
rasch(data = databersih, IRT.param = TRUE)

Total Information = 27.78
Information in (-4, 4) = 27.74 (99.85%)
Based on all the items
```

**Figure 10**. Tes Information Function

## Discussion

The cognitive test instrument developed consists of 12 items with the Computational Thinking model that has been declared valid. The results of the unidimensional test show that the cognitive test measures mathematical ability indicated by a scree plot based on eigenvalue. On the scree plot it is clear that there is 1 dominant factor, so the instrument is said to be unidimensional.[19] Evaluation of unidimensionality is important to ascertain whether the instrument measures what it is supposed to measure.[20] The local independent test also shows that although there is a violation of the local independent assumption, this does not interfere with the unidimensional assumption because the p-value > 0.05.[21] The reliability of the instrument is obtained as 0.8059, meaning that the reliability of the instrument is classified as good because it is above 0.7.[22]

The results of Rasch's analysis successfully showed that the mathematical cognitive test instrument model was included in the good fit of model category, indicated by the p-value > 0.05. Many instruments were also successfully developed using the Rasch model.[23] Based on the IIC curve, it is obtained that 3 items have a low level of difficulty, 6 questions have a medium level of difficulty, and 3 items have a high level of difficulty. TIF shows that this cognitive test instrument will be optimal if done by students with average ability with a level of ability to measure students' mathematical ability of 99.85%.

Therefore, this research has successfully constructed a cognitive test instrument with the Computational Thinking model consisting of 12 question items. The instrument can be used to measure mathematical cognitive abilities in the context of CT on the topic of matrices. The instrument can be used as a formative or summative test on matrix topics. Future research is expected to construct cognitive test instruments with CT models with other topics with a better number of items and test quality.

---

19 George Engelhard Jr, *Invariant measurement: Using Rasch models in the social, behavioral, and health sciences* (Routledge, 2013).

20 Shiau Wei Chan, Zaleha Ismail, dan Bambang Sumintono, "A Rasch Model Analysis on Secondary Students' Statistical Reasoning Ability in Descriptive Statistics," *Procedia - Social and Behavioral Sciences* 129 (Mei 2014): 133–39, https://doi.org/10.1016/j.sbspro.2014.03.658; Siti Shahirah Saidi dan Nyet Moi Siew, "Reliability and Validity Analysis of Statistical Reasoning Test Survey Instrument Using the Rasch Measurement Model," *International Electronic Journal of Mathematics Education* 14, no. 3 (29 April 2019), https://doi.org/10.29333/iejme/5755.

21 Saidi dan Siew, "Reliability and Validity Analysis of Statistical Reasoning Test Survey Instrument Using the Rasch Measurement Model"; Silin Wei, Xiufeng Liu, dan Yuane Jia, "USING RASCH MEASUREMENT TO VALIDATE THE INSTRUMENT OF STUDENTS' UNDERSTANDING OF MODELS IN SCIENCE (SUMS)," *International Journal of Science and Mathematics Education* 12, no. 5 (Oktober 2014): 1067–82, https://doi.org/10.1007/s10763-013-9459-z.

22 Ariffin dkk., "Validity and Reliability Multiple Intelligent Item Using Rasch Measurement Model"; Saidi dan Siew, "Reliability and Validity Analysis of Statistical Reasoning Test Survey Instrument Using the Rasch Measurement Model."

23 Caterina Primi dkk., "The Development and Testing of a New Version of the Cognitive Reflection Test Applying Item Response Theory (IRT)," *Journal of Behavioral Decision Making* 29, no. 5 (Desember 2016): 453–69, https://doi.org/10.1002/bdm.1883; Saidi dan Siew, "Reliability and Validity Analysis of Statistical Reasoning Test Survey Instrument Using the Rasch Measurement Model"; Wei, Liu, dan Jia, "USING RASCH MEASUREMENT TO VALIDATE THE INSTRUMENT OF STUDENTS' UNDERSTANDING OF MODELS IN SCIENCE (SUMS)."

**Applying Computational Thinking in Islamic Education (Madrasah)**

The current trend in Islamic education does not only focus on teaching religious sciences, but also begins to focus on the development of natural sciences, technology, and social sciences.[24] Islamic universities in Indonesia have begun to offer study programs that focus on the development of science and technology, such as computer science, data science, mathematics, actuarial science, etc. At the high school level, Madrasah Aliyah (Islamic education at the high school level) also continues to compete with other high schools. It is quite common for MA students to participate and even become top-ranked in various competitions in the field of natural sciences and technology.[25]

Islamic scholars made significant contributions to mathematics during the medieval period. Al-Khwarizmi, a prominent Muslim mathematician, developed algebra, and algorithms, and introduced the concept of zero, which revolutionized modern mathematics.[26] His work in algebra, arithmetic, and trigonometry laid the foundation for advancements in trade, mapping, and inheritance distribution. Other notable Muslim mathematicians like Ibn al-Haytham, al-Biruni, and Omar Khayyam contributed to various mathematical fields, including number theory, geometry, and trigonometry.[27] These contributions were often inspired by the Quran and Islamic principles, demonstrating the integration of faith and science. The impact of Islamic mathematics extended beyond the Muslim world, influencing European scientific development and helping to end the Dark Ages.[28] This rich mathematical heritage continues to be relevant in modern science and education.[29] Computational thinking has also flourished in the Islamic world, with many Muslim scientists contributing to the fields of artificial intelligence, big data analysis, and the development of sophisticated algorithms. This adaptation shows how Islamic intellectual heritage remains relevant and continues to evolve with the times.

The fact of technological advancement should be a trigger for Islamic education to quickly adapt and be able to participate in developing innovations. The hope is that Madrasah Aliyah students are not only experts in the field of religion but also experts in the field of modern technology, especially computing. This computational thinking problem was tested and focused

---

[24] Solihah Titin Sumanti, Nunzairina Nunzairina, dan Salminawati Salminawati, "The Evolution of Islamic Educational Institutions in North Sumatra Indonesia," *Nazhruna: Jurnal Pendidikan Islam* 7, no. 1 (7 Februari 2024): 1–19, https://doi.org/10.31538/nzh.v7i1.4419.

[25] Ali Musri Semjan Putra dan Kardina Engelina Siregar, "Challenges and Opportunities for Madrasah in Improving The Competence of Graduate Students," *Al-Tanzim: Jurnal Manajemen Pendidikan Islam* 7, no. 2 (19 April 2023): 492–505, https://doi.org/10.33650/al-tanzim.v7i2.4696; Anwar Sholikhin, "Innovation of Islamic Education (Multisite Study at Madrasah Aliyah Pesantren Al-Amin and Madrasah Aliyah Darul Hikmah, Mojokerto Regency)," *Journal of World Science* 2, no. 1 (16 Januari 2023): 75–88, https://doi.org/10.58344/jws.v2i1.114.

[26] M. Majid, "Angka Nol sebagai Kontribusi Muslim terhadap Matematika Modern," *Kalimah*, 2019; Dini Palupi Putri, "Peran Dan Kontribusi Ilmuwan Muslim Dalam Pembelajaran Matematika," *Arithmetic* 1, no. 1 (1 Mei 2019): 63–82, https://doi.org/10.29240/ja.v1i1.822.

[27] Liya Khaulah Asy-Syaimaa' Hussain dan A. Ramli, "Contributions of Islamic Civilization to The Mathematics Development," 2017; Putri, "Peran Dan Kontribusi Ilmuwan Muslim Dalam Pembelajaran Matematika."

[28] P.M.A Aleeshan, M.N.P. Rifasha, dan Mohamed Haniffa Mohamed Nairoos, "THE CONTRIBUTION OF MEDIEVAL MUSLIMS TO THE DEVELOPMENT OF MODERN SCIE NCE: A REVIEW OF ALKHWARIZMI," *International Journal of Social Science and Economic Research* 08, no. 02 (2023): 214–24, https://doi.org/10.46609/ijsser.2023.v08i02.001.

[29] Fatia Rahmanita, Durrotun Nashihah, dan M. F. Ramadhan, "Al-Khawarizmi Serta Kontribusinya Untuk Perkembangan Sains Modern," *Ulumuddin : Jurnal Ilmu-ilmu Keislaman*, 2023.

on Madrasah Aliyah students, with the intention that Madrasah aliyah students are increasingly trained and literate in technology. The tested computational thinking problems were developed using the principles of computational thinking popularised by Dagiene, which include abstraction, algorithms, decomposition, and pattern recognition.[30] The developed computational thinking instrument can be used as an alternative to measure and train students' computational thinking skills in mathematics. The instrument can also be used as a summative test or as a diagnostic test. This instrument is still limited to mathematics learning, further research is expected to develop computational thinking instruments in other subjects. Given that the indicators of computational thinking are very flexible and dynamic, it is possible that religious subjects can also use computational thinking as the basis for the preparation of test questions, be it diagnostic, formative, or summative.

## CONCLUSION

The Cognitive Test Instrument of Computational Thinking model developed has been proven to be valid and reliable. The quality of the test instrument is also quite good (good fit of model) and the instrument effectively measures latent variables with a percentage of 99.85%. The test instrument will be optimal if done by students with average ability. This research shows that computational thinking is very likely to be applied in madrasah, and integrated into the subjects. This research is limited to one mathematics topic (matrix), further research is expected to construct other computational thinking problems on different mathematics topics or even on social and religious subjects. Another limitation of this research is the sample size, although based on the sample adequacy test, future research needs to increase the sample size to be more representative. The unequal gender proportion is also a limitation. A total of Madrasahs need to formulate policies for the implementation of computational thinking in the intracurricular curriculum to improve the quality and competitiveness of madrasah students.

## ACKNOWLEDGMENT

The author would like to thank the LPDP of the Ministry of Finance of the Republic of Indonesia for providing financial support so that this research can be completed. Thanks also go to Yogyakarta State University for providing moral support and knowledge to the author. The author would like to express gratitude to Prof. Erna Andriyanti S.S., M.Hum., Ph.D. for her invaluable contribution of writing expertise and motivation, which greatly facilitated the completion of this article.

[30] Diah Nuraisa dkk., "Exploring Students Computational Thinking Based on Self-Regulated Learning in the Solution of Linear Program Problem," *JIPM (Jurnal Ilmiah Pendidikan Matematika)* 8, no. 1 (27 September 2019): 30, https://doi.org/10.25273/jipm.v8i1.4871; Christian P. Brackmann dkk., "Development of Computational Thinking Skills through Unplugged Activities in Primary School," dalam *Proceedings of the 12th Workshop on Primary and Secondary Computing Education* (WiPSCE '17: 12th Workshop in Primary and Secondary Computing Education, Nijmegen Netherlands: ACM, 2017), 65–72, https://doi.org/10.1145/3137065.3137069; Yihuan Dong dkk., "PRADA: A Practical Model for Integrating Computational Thinking in K-12 Education," dalam *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (SIGCSE '19: The 50th ACM Technical Symposium on Computer Science Education, Minneapolis MN USA: ACM, 2019), 906–12, https://doi.org/10.1145/3287324.3287431.

## REFERENCES

Adler, Rachel F., dan Hanna Kim. "Enhancing Future K-8 Teachers' Computational Thinking Skills through Modeling and Simulations." *Education and Information Technologies* 23, no. 4 (Juli 2018): 1501–14. https://doi.org/10.1007/s10639-017-9675-1.

Afriansyah, Ekasatya Aldila, Tatang Herman, Turmudi, dan Jarnawi Afgani Dahlan. "Critical thinking skills in mathematics." *Journal of Physics: Conference Series*. IOP Publishing, 2021. https://doi.org/10.1088/1742-6596/1778/1/012013.

Aini, Nur Rohmatul, Syafrimen Syafril, Netriwati Netriwati, Agus Pahrudin, Titik Rahayu, dan Vicka Puspasari. "Problem Based Learning for Mathematics Critical Thinking Skills." Center for Open Science, 2018. https://doi.org/10.31219/osf.io/968pg.

Aleeshan, P.M.A, M.N.P. Rifasha, dan Mohamed Haniffa Mohamed Nairoos. "The Contribution Of Medieval Muslims To The Development Of Modern Scie Nce: A Review Of Alkhwarizmi." *International Journal of Social Science and Economic Research* 08, no. 02 (2023): 214–24. https://doi.org/10.46609/ijsser.2023.v08i02.001.

Allsop, Yasemin. "Assessing Computational Thinking Process Using a Multiple Evaluation Approach." *International Journal of Child-Computer Interaction* 19 (Maret 2019): 30–55. https://doi.org/10.1016/j.ijcci.2018.10.004.

Angeli, Charoula, dan Michail Giannakos. "Computational Thinking Education: Issues and Challenges." *Computers in Human Behavior* 105 (April 2020): 106185. https://doi.org/10.1016/j.chb.2019.106185.

Anjum, Ubair. "Assessing the Need of Modern Education in Madrassah System: A Case Study of Madaris in Lahore." *Arts and Social Sciences Journal* 08, no. 04 (2017). https://doi.org/10.4172/2151-6200.1000286.

Arastoopour Irgens, Golnaz, Sugat Dabholkar, Connor Bain, Philip Woods, Kevin Hall, Hillary Swanson, Michael Horn, dan Uri Wilensky. "Modeling and Measuring High School Students' Computational Thinking Practices in Science." *Journal of Science Education and Technology* 29, no. 1 (Februari 2020): 137–61. https://doi.org/10.1007/s10956-020-09811-1.

Ariffin, Siti Rahayah, Bishanani Omar, Anita Isa, dan Sharida Sharif. "Validity and Reliability Multiple Intelligent Item Using Rasch Measurement Model." *Procedia - Social and Behavioral Sciences* 9 (2010): 729–33. https://doi.org/10.1016/j.sbspro.2010.12.225.

Arnulfo Perez. "A Framework for Computational Thinking Dispositions in Mathematics Edu cation." *Journal for Research in Mathematics Education*, 2018.

Balkist, Pujia Siti, dan Dadang Juandi. "Trend of critical thinking skill studies in mathematics education: A study design to data analysis." *International Journal of Trends in Mathematics Education Research*. SAINTIS Publishing, 2022. https://doi.org/10.33122/ijtmer.v5i4.166.

Basu, Satabdi, Gautam Biswas, Pratim Sengupta, Amanda Dickes, John S. Kinnebrew, dan Douglas Clark. "Identifying Middle School Students' Challenges in Computational Thinking-Based Science Learning." *Research and Practice in Technology Enhanced Learning* 11, no. 1 (Desember 2016): 13. https://doi.org/10.1186/s41039-016-0036-2.

Brackmann, Christian P., Marcos Román-González, Gregorio Robles, Jesús Moreno-León, Ana Casali, dan Dante Barone. "Development of Computational Thinking Skills through Unplugged Activities in Primary School." Dalam *Proceedings of the 12th Workshop on Primary and Secondary Computing Education*, 65–72. Nijmegen Netherlands: ACM, 2017. https://doi.org/10.1145/3137065.3137069.

Chan, Shiau Wei, Zaleha Ismail, dan Bambang Sumintono. "A Rasch Model Analysis on Secondary Students' Statistical Reasoning Ability in Descriptive Statistics." *Procedia* -

*Social and Behavioral Sciences* 129 (Mei 2014): 133–39. https://doi.org/10.1016/j.sbspro.2014.03.658.

Dagienė, Valentina, dan Sue Sentance. "It's Computational Thinking! Bebras Tasks in the Curriculum." Dalam *Informatics in Schools: Improvement of Informatics Knowledge and Perception*, disunting oleh Andrej Brodnik dan Françoise Tort, 9973:28–39. Lecture Notes in Computer Science. Cham: Springer International Publishing, 2016. https://doi.org/10.1007/978-3-319-46747-4_3.

Dong, Yihuan, Veronica Catete, Robin Jocius, Nicholas Lytle, Tiffany Barnes, Jennifer Albert, Deepti Joshi, Richard Robinson, dan Ashley Andrews. "PRADA: A Practical Model for Integrating Computational Thinking in K-12 Education." Dalam *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*, 906–12. Minneapolis MN USA: ACM, 2019. https://doi.org/10.1145/3287324.3287431.

Engelhard Jr, George. *Invariant measurement: Using Rasch models in the social, behavioral, and health sciences*. Routledge, 2013.

Esteve-Mon, Francesc M., M. Ángeles Llopis, dan Jordi Adell-Segura. "Digital Competence and Computational Thinking of Student Teachers." *International Journal of Emerging Technologies in Learning (iJET)* 15, no. 02 (29 Januari 2020): 29. https://doi.org/10.3991/ijet.v15i02.11588.

Faradillah, Ayu, dan Sabila Adlina. "Validity of critical thinking skills instrument on prospective Mathematics teachers." *Jurnal Penelitian dan Evaluasi Pendidikan*. Universitas Negeri Yogyakarta, 2021. https://doi.org/10.21831/pep.v25i2.40662.

Fatia Rahmanita, Durrotun Nashihah, dan M. F. Ramadhan. "Al-Khawarizmi Serta Kontribusinya Untuk Perkembangan Sains Modern." *Ulumuddin : Jurnal Ilmu-ilmu Keislaman*, 2023.

Gretter, Sarah, dan Aman Yadav. "Computational Thinking and Media & Information Literacy: An Integrated Approach to Teaching Twenty-First Century Skills." *TechTrends* 60, no. 5 (September 2016): 510–16. https://doi.org/10.1007/s11528-016-0098-4.

Harjo, B. "Development of critical thinking skill instruments on mathematical learning high school." *International Journal of Instruction*, 2019. https://doi.org/10.29333/iji.2019.12410a.

Imaduddin, Muhamad, Muhammad Mujahidus Shofa, Muhammad Fatkhur Riza, dan Achmad Ali Fikri. "Exploring the Pre-Service Basic Science Teachers' Misconceptions Using the Six-Tier Diagnostic Test." *International Journal of Evaluation and Research in Education (IJERE)* 12, no. 3 (1 September 2023): 1626. https://doi.org/10.11591/ijere.v12i3.24603.

Indri Mahmudah dan Muqowim Muqowim. "Integration Of Islamic Values In Mathematics Learning In Class IV Stud ents Of Madrasah Ibtidaiyah." *Al-Madrasah: Jurnal Pendidikan Madrasah Ibtidaiyah*, 2022.

Kale, Ugur, Mete Akcaoglu, Theresa Cullen, Debbie Goh, Leah Devine, Nathan Calvert, dan Kara Grise. "Computational What? Relating Computational Thinking to Teaching." *TechTrends* 62, no. 6 (November 2018): 574–84. https://doi.org/10.1007/s11528-018-0290-9.

Kusno Kusno, M. Marsigit, dan M. Yaakob. "Integration of islamic spiritual values with mathematics teaching," 2020.

Liya Khaulah Asy-Syaimaa' Hussain dan A. Ramli. "Contributions of Islamic Civilization to The Mathematics Development," 2017.

M. Majid. "Angka Nol sebagai Kontribusi Muslim terhadap Matematika Modern." *Kalimah*, 2019.

Moreno-León, Jesús, Marcos Román-González, Casper Harteveld, dan Gregorio Robles. "On the Automatic Assessment of Computational Thinking Skills: A Comparison with Human Experts." Dalam *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 2788–95. Denver Colorado USA: ACM, 2017. https://doi.org/10.1145/3027063.3053216.

Mulyati, Tita, Wahyudin Wahyudin, Tatang Herman, dan Tatang Mulyana. "Effect of Integrating Children's Literature and SQRQCQ Problem Solving Learning on Elementary School Student's Mathematical Reading Comprehension Skill." *International Electronic Journal of Mathematics Education* 12, no. 3 (29 Mei 2017): 217–32. https://doi.org/10.29333/iejme/610.

Nardelli, Enrico. "Do We Really Need Computational Thinking?" *Communications of the ACM* 62, no. 2 (28 Januari 2019): 32–35. https://doi.org/10.1145/3231587.

Nuraisa, Diah, Amalina Nur Azizah, Dian Nopitasari, dan Swasti Maharani. "Exploring Students Computational Thinking Based on Self-Regulated Learning in the Solution of Linear Program Problem." *JIPM (Jurnal Ilmiah Pendidikan Matematika)* 8, no. 1 (27 September 2019): 30. https://doi.org/10.25273/jipm.v8i1.4871.

Othman, Norasmah Binti, Suria Mohd Salleh, dan Haliza Hussein. "Assessing Construct Validity And Reliability Of Competitiveness Scale Using Rasch Model Approach," 2014.

ÖZYURT, Özcan. "Examining the Critical Thinking Dispositions and the Problem Solving Skills of Computer Engineering Students." *EURASIA Journal of Mathematics, Science and Technology Education*. Modestum Publishing Ltd, 2015. https://doi.org/10.12973/eurasia.2015.1342a.

Plomp, Tjeerd. "Educational design research: An introduction." *Educational design research*, 2013, 11–50.

Primi, Caterina, Kinga Morsanyi, Francesca Chiesi, Maria Anna Donati, dan Jayne Hamilton. "The Development and Testing of a New Version of the Cognitive Reflection Test Applying Item Response Theory (IRT)." *Journal of Behavioral Decision Making* 29, no. 5 (Desember 2016): 453–69. https://doi.org/10.1002/bdm.1883.

Putra, Ali Musri Semjan, dan Kardina Engelina Siregar. "Challenges and Opportunities for Madrasah in Improving The Competence of Graduate Students." *Al-Tanzim: Jurnal Manajemen Pendidikan Islam* 7, no. 2 (19 April 2023): 492–505. https://doi.org/10.33650/al-tanzim.v7i2.4696.

Putri, Dini Palupi. "Peran Dan Kontribusi Ilmuwan Muslim Dalam Pembelajaran Matematika." *Arithmetic* 1, no. 1 (1 Mei 2019): 63–82. https://doi.org/10.29240/ja.v1i1.822.

Romadiastri, Y. "Mathematical critical thinking ability: The effect of scale difference on integral." *IOP Conference Series: Earth and Environmental Science*, 2021. https://doi.org/10.1088/1742-6596/1796/1/012120.

Rosyadi, Imron, Andika Aprilianto, dan Muhammad Husnur Rofiq. "Development of Islamic Educational Institutions in Increasing Competitiveness in Madrasah Tsanawiyah." *Chalim Journal of Teaching and Learning* 3, no. 1 (18 September 2023): 52–63. https://doi.org/10.31538/cjotl.v3i1.723.

Saidi, Siti Shahirah, dan Nyet Moi Siew. "Reliability and Validity Analysis of Statistical Reasoning Test Survey Instrument Using the Rasch Measurement Model." *International Electronic Journal of Mathematics Education* 14, no. 3 (29 April 2019). https://doi.org/10.29333/iejme/5755.

Sholikhin, Anwar. "Innovation of Islamic Education (Multisite Study at Madrasah Aliyah Pesantren Al-Amin and Madrasah Aliyah Darul Hikmah, Mojokerto Regency)." *Journal of World Science* 2, no. 1 (16 Januari 2023): 75–88. https://doi.org/10.58344/jws.v2i1.114.

So, Hyo-Jeong, Morris Siu-Yung Jong, dan Chen-Chung Liu. "Computational Thinking Education in the Asian Pacific Region." *The Asia-Pacific Education Researcher* 29, no. 1 (Februari 2020): 1–8. https://doi.org/10.1007/s40299-019-00494-w.

Sodik, Jakfar. "Strategy For Increasing The Competitiveness Of Madrasah" 1, No. 1 (2023).

Sumanti, Solihah Titin, Nunzairina Nunzairina, dan Salminawati Salminawati. "The Evolution of Islamic Educational Institutions in North Sumatra Indonesia." *Nazhruna: Jurnal Pendidikan Islam* 7, no. 1 (7 Februari 2024): 1–19. https://doi.org/10.31538/nzh.v7i1.4419.

Szabo, Zsuzsanna Katalin, Péter Körtesi, Jan Guncaga, Dalma Szabo, dan Ramona Neag. "Examples of Problem-Solving Strategies in Mathematics Education Supporting the Sustainability of 21st-Century Skills." *Sustainability* 12, no. 23 (3 Desember 2020): 10113. https://doi.org/10.3390/su122310113.

Wei, Silin, Xiufeng Liu, dan Yuane Jia. "Using Rasch Measurement To Validate The Instrument Of Students' Understanding Of Models In Science (Sums)." *International Journal of Science and Mathematics Education* 12, no. 5 (Oktober 2014): 1067–82. https://doi.org/10.1007/s10763-013-9459-z.

Widihastut, Supahar, Syukrul Hamdi, dan Edi Istiyono. "Measuring Creative Thinking Skills of Senior High School Male and Female Students in Physics (CTSP)Using the IRT-Based PhysTCreTS." *Turkish Journal of Science Education* 17, no. 4 (21 Juli 2020): 578–90. https://doi.org/10.36681/tused.2020.46.

Ye, Huiyan, Biyao Liang, Oi-Lam Ng, dan Ching Sing Chai. "Integration of computational thinking in K-12 mathematics education: a systematic review on CT-based mathematics instruction and student learning." *International Journal of STEM Education*. Springer Science and Business Media LLC, 2023. https://doi.org/10.1186/s40594-023-00396-w.

Zahid, Muhammad Zuhair. "Telaah kerangka kerja PISA 2021: era integrasi computational thinking dalam bidang matematika" 3 (2020).