

Validation of CORE-Model-Based Geometry Teaching Materials Supported by Wingeom Software

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ABSTRACT

This study aims to evaluate the content validity of geometry teaching materials designed for Grade VII junior high school students. These materials were developed using the Connecting, Organizing, Reflecting, and Extending (CORE) instructional model, supported by Wingeom software, to enhance students' conceptual understanding of geometry. To assess validity, expert validation was conducted using structured questionnaires. Six categories of experts participated: subject-matter experts, media experts, mathematicians, school mathematicians, language experts, and learning evaluation experts. Each category included five experts. The Content Validity Index (CVI) was employed to quantify the degree of agreement among experts regarding the relevance of the materials. The results showed high content validity across all expert groups. Specifically, the s-CVI values were 0.96 for media experts, 0.98 for subject-matter experts, 0.97 for mathematicians, 0.96 for school mathematicians, and similarly high scores for evaluation and language experts. These scores exceed the commonly accepted threshold for strong content validity ($s\text{-CVI} \geq 0.90$). The high CVI values indicate that the geometry teaching materials are valid in terms of content, language, instructional design, and evaluation components. Consequently, the materials are appropriate for use in further research related to mathematics learning processes at the junior high school level.

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1. INTRODUCTION

Geometry learning in junior high school is pivotal for cultivating students' logical and systematic thinking, enabling them to interpret mathematical ideas and solve problems embedded in daily life contexts (Abdussakir, 2009; Afriansyah, 2022). As mathematics is taught continuously from elementary through higher education and underpins multiple domains of human activity, its instruction must foster critical, logical, effective, and efficient reasoning in problem solving (Fauziah & Puspitasari, 2022; Nissa, Febrilia, & Pangga, 2023; Kurniasari & Sritresna, 2022; Ulkhaq, 2023; Jamil, Sa'diah, & Afriansyah, 2023). Within this trajectory, conceptual understanding functions as the bedrock of mathematical competence.

In the topic of plane and solid figures, robust concept mastery at the junior high level becomes a prerequisite for subsequent materials and supports transfer across topics (Hakim & Ramlah, 2020; Wulandari, Suwanto, & Novaliyosi, 2021; Sofiani, Nurjamil, & Nurhayati, 2023; Meilina, Mariana, & Rahmawati, 2023).

However, classroom evidence reveals persistent difficulties in geometry, particularly in conceptual tasks and problem solving on plane and solid figures. These difficulties manifest as errors, fragmented knowledge, and failure to connect interrelated concepts, which then propagate to learning obstacles in later topics (Sholihah & Afriansyah, 2017; Sumiati & Agustini, 2020; Ramdhani, 2017; Ristiani & Maryati, 2022; Ole & Dipan, 2023; Hidayah & Fitriani, 2021; Ulfa & Sundayana, 2022). Contributing factors include suboptimal pedagogical use of technology, limited availability or utilization of appropriate learning media, and waning student motivation. In three-dimensional solids with flat sides, abstractness and spatial visualization demands exacerbate these hurdles.

Addressing these gaps requires an approach that simultaneously strengthens students' conceptual networks and renders abstract objects perceptually accessible. Two complementary levers are promising. First, the CORE learning model—Connecting, Organizing, Reflecting, Extending—provides a student-centered, discussion-rich structure that activates prior knowledge, organizes new ideas, elicits metacognitive reflection, and promotes knowledge extension, aligning with constructivist principles and reflective thinking development (Miller & Calfee, 2004; Curwen, Miller, White-Smith, & Calfee, 2010). Second, dynamic geometry software such as Wingeom functions as a mindtool that externalizes and animates geometric relationships in 2D and 3D, enabling students to explore, observe, and simulate transformations of shapes; in turn, it clarifies difficult concepts and supports internal visualization (Gusnidar, Netriwati, & Putra, 2018).

This study positions the integration of CORE with Wingeom as an instructional design for junior high geometry, specifically on three-dimensional solids with flat sides. The innovation lies in translating ethical and pedagogical commitments—clarity, transparency of process, and learner agency—into auditable instructional decisions: structured CORE cycles for cognitive scaffolding; explicit visualization tasks and simulations in Wingeom for spatial reasoning; and documented learning artifacts for reflection and extension. By aligning a process-oriented pedagogy with visualization technology, the design is expected to reduce conceptual errors, strengthen connections across geometric ideas, and enhance students' problem-solving readiness.

Therefore, the purpose of this study is to develop and validate CORE-based geometry teaching materials supported by Wingeom software for the topic of three-dimensional solids with flat sides. Specifically, the study aims to: (1) produce teaching materials and learning activities that meet expert validity criteria; and (2) demonstrate their potential effectiveness in addressing students' conceptual and procedural difficulties through improved visualization, organization of ideas, and reflective extension. This responds to documented classroom challenges and advances beyond prior works that focus solely on principles or perceptions by mapping a concrete, technology-supported learning process that can be implemented, audited, and evaluated in real classrooms.

2. METHODS

The research method used in this study is the Research and Development (R&D) method. R&D is a research approach that aims to produce a specific product and test its effectiveness (Sugiyono, 2016). This study follows the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) developed by Dick and Carey (Mulyatiningsih, 2012).

In the Development stage, validation and revision of the resulting product are carried out. This process is conducted based on discussions and input from experts. According to Purwanto (2008), validity testing can be conducted through three methods, namely item review, soliciting expert input, and analyzing item-total correlations. The product validated is a geometry teaching material. The validation process involves input from six experts, namely five material experts, five media experts,

five evaluation experts, five mathematics experts, five school mathematics experts, and five learning evaluation experts. The experts' input is used to assess the content validity of the teaching materials.

After the researcher designs the product, the third stage of this study focuses on developing the final product, which is then validated by five expert teams, namely material experts, media experts, mathematics experts, school mathematics experts, and learning evaluation experts. Feedback from the experts is used to assess the content validity of the developed teaching materials. In this study, content validity refers to testing the alignment between the teaching materials and the sub-achievement of the assessment indicators.

During the development stage, the validity of the prepared teaching materials is assessed. Internal validity, which includes content validity, is evaluated to ensure that the teaching materials are aligned with the research objectives. To ensure the accuracy and relevance of the content, professionals are involved in the process. In this study, five experts are employed to review the geometry teaching materials to establish better criterion referencing (Hendryadi, 2017). Various methods are available to assess the validity of research instruments, including Aiken's V for content validity, Lawshe's Content Validity Ratio (CVR), the Content Validity Index (CVI), and interrater reliability (Kappa statistics). This study employs the CVI, a method that has been widely used over the past decade (Hendryadi, 2017).

Experts are individuals who have skills and knowledge relevant to the research being conducted. At least three specialists are usually required to evaluate a research instrument. However, it is not recommended to assess an instrument with more than ten experts, as suggested by Lynn (1986). To obtain a more reliable CVI value, the involvement of at least six experts is recommended, according to Hendryadi (2017). When processing expert validation sheets using the CVI approach, the measurement scale is dichotomous, with a value of 0 indicating "inadequate" and a value of 1 indicating "adequate" (Denis F. Polit & Beck, 2006).

Validity testing of the instrument using the Content Validity Index (CVI) approach involves two categories: calculating the content validity of each item (i-CVI) and the overall scale content validity (s-CVI). A research instrument is considered relevant if it has a minimum i-CVI value of 1.00 (Lynn, 1986; Denise F. Polit et al., 2007). In addition, other researchers have shown that a research instrument demonstrates very high validity if the i-CVI value ranges between 0.800 and 1.00 (Guilford & Fruchter, 1978).

There are six steps in the content validity testing procedure. The steps are as follows: (1) prepare the content validation sheet, (2) select experts, (3) conduct content validation, (4) review the domain of each item, (5) score each item, and (6) calculate the CVI (Yusoff, 2019).

The six steps are explained below:

1. Prepare the content validation sheet

The content validation sheet is designed to help experts understand the type of assessment they should provide. The rating scale used in the content validation sheet is dichotomous, with a value of 0 indicating that the item is not relevant, and a value of 1 indicating that the item is relevant.

2. Select an expert

Experts are selected based on their respective expertise relevant to the research objectives. The number of experts that can be used as raters is shown in Table 2 below.

Table 2. Number of Experts and Criteria for Determining Content Validity with CVI

Number of Experts	Acceptable CVI Value	Recommended Source
2 experts	≥ 0.80	Davis (1992)
3–5 experts	1.00 (must)	Polit & Beck (2006); Polit et al. (2007)
≥ 6 experts	≥ 0.83	Polit & Beck (2006); Polit et al. (2007)
6–8 experts	≥ 0.83	Lynn (1986)
≥ 9 experts	≥ 0.78	Lynn (1986)

- Other criteria that can be used to determine validation results are (Guilford & Fruchter, 1978):
- a. $0.80 \leq \text{Average I-CVI} \leq 1.00$: very high validity (very good)
 - b. $0.60 \leq \text{Average I-CVI} \leq 0.80$: high validity (good)
 - c. $0.40 \leq \text{Average I-CVI} \leq 0.60$: moderate validity (fair)
 - d. $0.20 \leq \text{Average I-CVI} \leq 0.40$: low validity (poor)
 - e. $0.00 \leq \text{Average I-CVI} \leq 0.20$: very low validity (bad)
 - f. $\text{Average I-CVI} \leq 0.00$: not valid
3. Conduct content validation
Content validation can be carried out face-to-face or online. In this study, content validation is conducted both face-to-face and online. In cases where several validators cannot be met directly, validation is conducted online by sending the validation files to the experts and vice versa via email.
 4. Review aspects and items
The content validation sheet in this study consists of five instruments, namely media experts, material experts, evaluation experts, mathematics experts, school mathematics experts, and language experts. The experts are asked to read carefully before giving scores (Yusoff). In addition, validation is also conducted for each item.
 5. Score each item
After reviewing each aspect and item, the experts are asked to provide scores as described in step 1. In addition, the experts are also asked to provide additional comments as input for improvement and to choose a conclusion for the continuation of the teaching materials. The conclusion options used are: 1) valid and feasible to use; 2) valid and feasible to use with revisions; 3) not valid and not feasible to use.
 6. Calculate the CVI
The calculation of the CVI includes calculating the i-CVI and s-CVI values. The calculation steps use the criteria that 0 means not relevant and 1 means relevant. Next, from the five experts, the average for each item is calculated, which is called the i-CVI, and the average of the i-CVI becomes the s-CVI value.

Table 3. Definitions and formulas for I-CVI, S-CVI/Ave, and S-CVI/UA

CVI Index	Definition	Formula
I-CVI (Item-level Content Validity Index)	Proportion of content experts who rate an item as relevant (0 = not relevant; 1 = relevant).	$\text{I-CVI} = (\text{Number of experts agreeing on the item}) / (\text{Total number of experts})$
S-CVI/Ave (Scale-level CVI by average method)	Average of I-CVI across all items on the scale; equivalently, the average relevance proportion rated by all experts.	$\text{S-CVI/Ave} = (\text{Sum of I-CVI scores}) / (\text{Number of items})$
S-CVI/UA (Scale-level CVI by universal agreement)	Proportion of items that achieve 100% expert agreement on relevance. UA for an item = 1 if all experts agree; otherwise 0.	$\text{S-CVI/UA} = (\text{Number of items with UA} = 1) / (\text{Total number of items})$

Note: Definitions and formulas are based on recommendations by Lynn (1986), Davis (1992), Polit & Beck (2006), and Polit et al. (2007).

Methodology – Additional Details (Narrative)

The expert panel in this study comprised domain specialists whose profiles align with the instruments under review. Material experts were mathematics education lecturers from two public universities and one teacher training institute, each with 7–15 years of experience teaching geometry, authoring junior high mathematics modules, and reviewing national curriculum materials. Media experts were educational technology lecturers and instructional designers from university centers for learning innovation, with 5–12 years of experience designing interactive digital materials and

established competence in multimedia standards, usability, and accessibility. Mathematics experts were faculty members in pure or applied mathematics with 8–20 years of service who ensured content rigor and coherence with school mathematics. School mathematics experts were practicing junior high mathematics teachers from three public schools and one private school, with 6–18 years of classroom practice and certification as master teachers for grades 7–9. Evaluation and learning assessment experts were lecturers in educational measurement with 10–22 years of experience in instrument validation, rubric design, and classroom assessment. A language expert, an academic writing and Indonesian/ELT lecturer with eight years of experience, cross-checked clarity, readability, and consistency across all materials. Consistent with recommendations for robust CVI estimation, at least five experts reviewed each instrument, with a minimum of six total experts engaged across the panel.

Validation proceeded through a structured workflow over approximately seven weeks. In the preparation phase (week 1), the research team finalized the expert list, secured consent, and assembled validation packets containing a syllabus alignment matrix, lesson outlines integrating the CORE model with Wingeom activities, sample screens and animations, teacher and learner worksheets, assessment rubrics, and validation sheets using a dichotomous 0/1 scale. Round one validation (weeks 2–3) used a hybrid mode. Material and media experts met face-to-face in two 120-minute sessions at a university learning laboratory for a guided walkthrough and live Wingeom demonstration, while mathematics, school mathematics, and evaluation experts reviewed asynchronously via a cloud folder. Clarifications were handled through a WhatsApp or Telegram group, and brief Zoom check-ins (about 30 minutes) were scheduled as needed. Experts were given ten calendar days to return scored sheets and narrative comments.

In week 4, the team synthesized quantitative and qualitative feedback. Item-level CVI (i-CVI) values were computed for each item, and scale-level CVI by average (s-CVI/Ave) was calculated for each instrument. Qualitative comments were thematically coded and used to revise content sequencing, visual design, task prompts, Wingeom screenshots and animations, and analytic rubrics. Round two validation (weeks 5–6) was conducted online. Revised materials were distributed with a detailed change log, and experts had seven calendar days to respond. Decision rules specified that items with i-CVI below 0.83 (given panels of six or more experts) required mandatory revision, and instruments should reach s-CVI/Ave of at least 0.90 before implementation. In week 7, the language expert performed final proofreading to ensure clarity, terminology consistency, and readability, after which the materials were frozen for the implementation phase.

Communication and data management were standardized to ensure traceability. Email was used for document exchange, Zoom for synchronous walkthroughs, and WhatsApp or Telegram for rapid queries. All files were stored in a version-controlled cloud repository organized by instrument, with filenames that encoded date and version (for example, "Module3_Prism_v1_2025-03-10.pdf"). The research team maintained attendance logs, meeting minutes, change logs, and archived validation sheets to produce an auditable trail of decisions and revisions.

The CVI computation followed established procedures. Each item received a dichotomous rating where 0 indicated "not relevant" and 1 indicated "relevant." The i-CVI for an item was the proportion of experts assigning a rating of 1. The s-CVI/Ave was the mean of i-CVI values across all items within an instrument, while the s-CVI/UA represented the proportion of items achieving universal agreement (all experts rating 1). Acceptance thresholds were set with reference to Lynn (1986), Polit and Beck (2006), and Hendryadi (2017): i-CVI values of at least 0.83 were expected for panels of six or more experts, and instruments were targeted to achieve s-CVI/Ave of 0.90 or higher prior to deployment. Interpretations of the average i-CVI followed the Guilford and Fruchter categories.

To manage risks and assure quality, the panel intentionally combined academics and practitioners to mitigate single-perspective bias; reviewer identities were anonymized during aggregation; and a second coder verified all CVI calculations, with discrepancies resolved by consensus. A feasibility check was also conducted by testing Wingeom files on school laboratory computers and preparing an offline

package for low-connectivity contexts, thereby ensuring that the validated materials could be implemented reliably in the intended classroom settings.

3. FINDINGS AND DISCUSSION

This study produced two datasets: expert validation data and item-level instrument validation data. The expert validation data are presented in Table 2, while the item-level instrument validation data are presented in Table 3. Table 2 presents the results of content validation of the complete instruments, as assessed by five validators across six expert domains: media, material, mathematics, school mathematics, evaluation, and linguistics. The validation includes 50 statements from media experts, 20 from material experts, 23 from mathematics experts, 20 from school mathematics experts, 20 from evaluation experts, and 20 from linguistics experts.

The average i-CVI value was determined by averaging the i-CVI scores for each aspect. The overall average i-CVI value was designated as the s-CVI. As shown in Table 2, the s-CVI values are as follows: material experts, 0.96; media experts, 0.99; evaluation experts, 0.98; mathematics experts, 0.96; school mathematics experts, 0.98; and language experts, 0.97. The CVI acceptance criterion for five experts, as detailed in Table 1, is 1 (Lynn, 1986; Polit et al., 2007). Therefore, based on the expert validation data and the calculated i-CVI and s-CVI values, the CORE-model Geometry teaching materials supported by Wingeom software can be considered feasible and relevant.

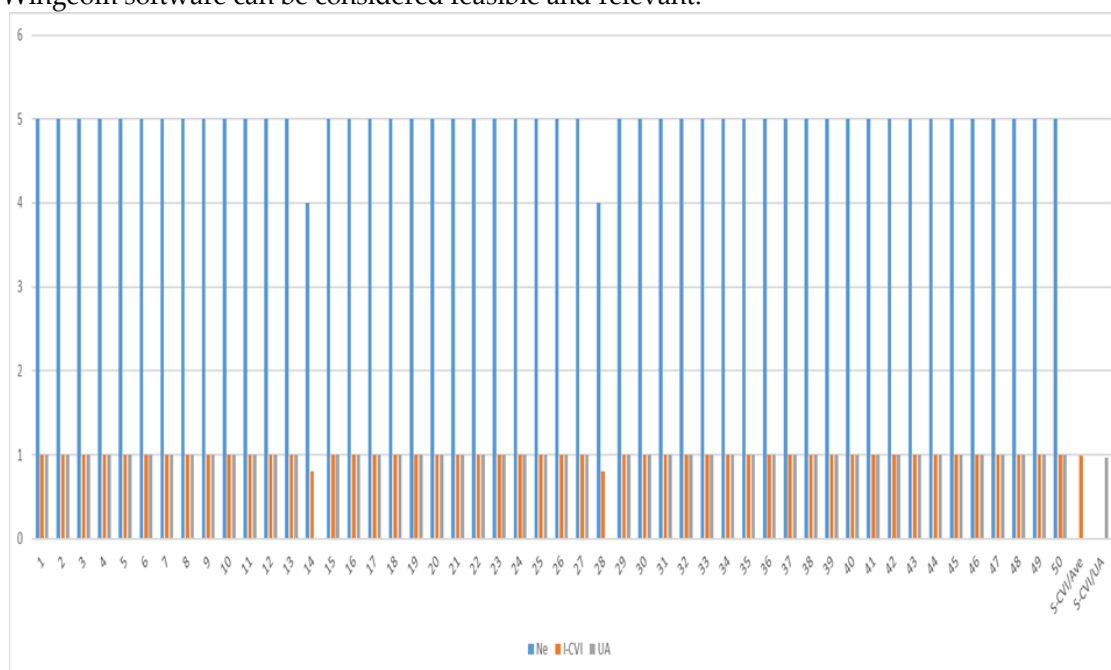


Figure 1. Results of i-CVI and s-CVI validation analysis by media experts

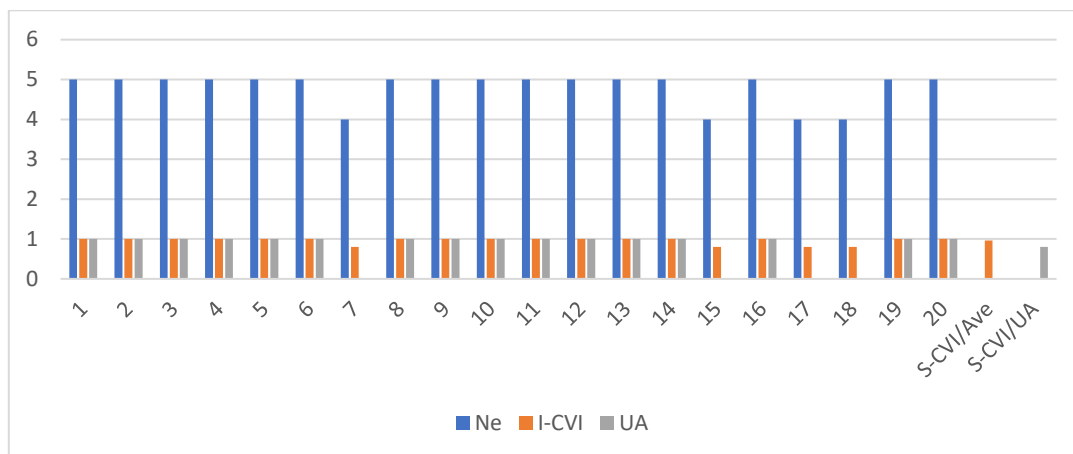


Figure 2. Results of i-CVI and s-CVI validation analysis by material experts

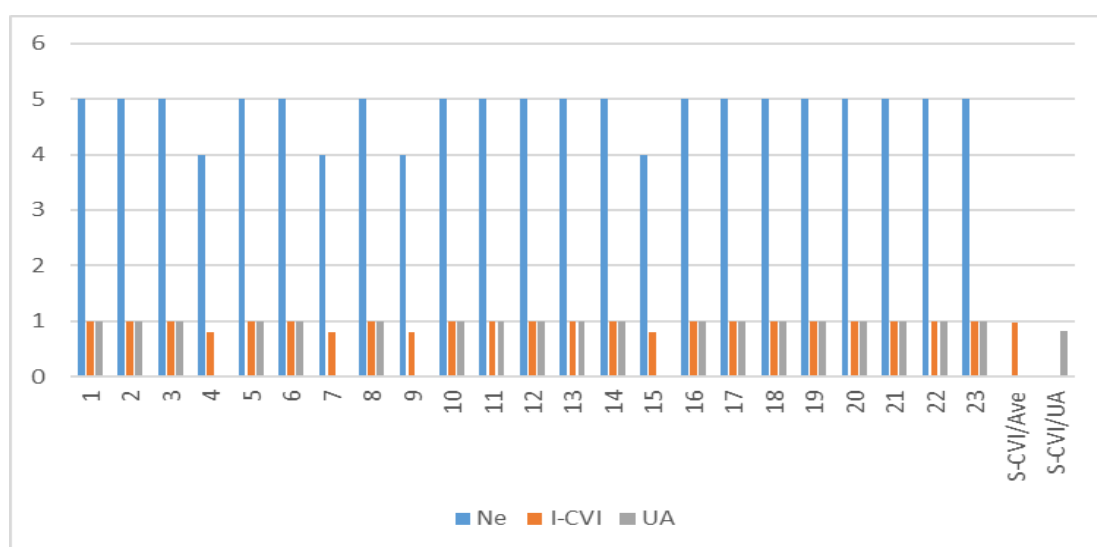


Figure 3. Results of i-CVI and s-CVI validation analysis by mathematics experts

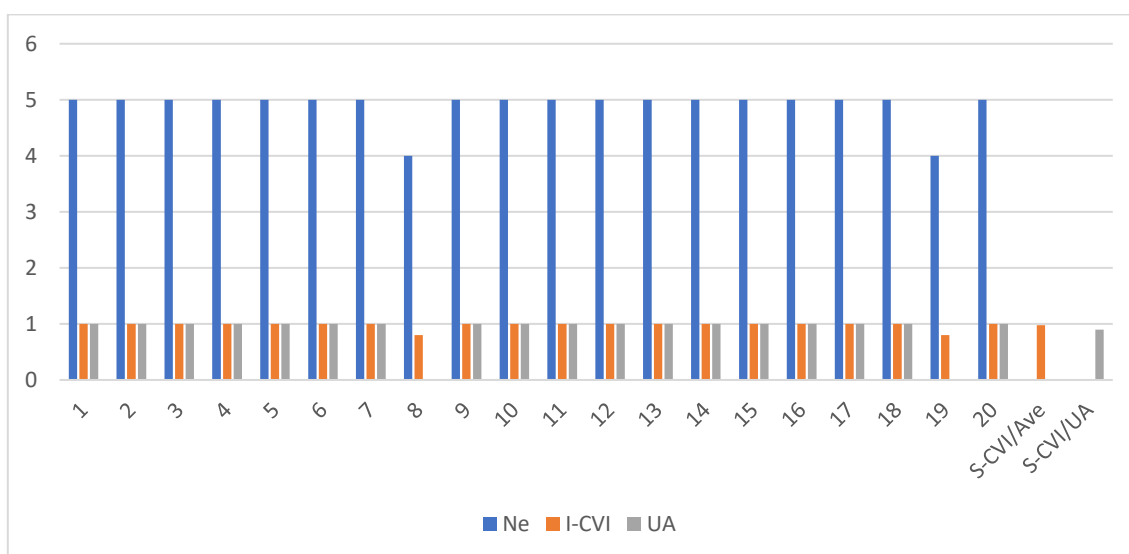


Figure 4. Results of i-CVI and s-CVI validation analysis by school mathematics experts

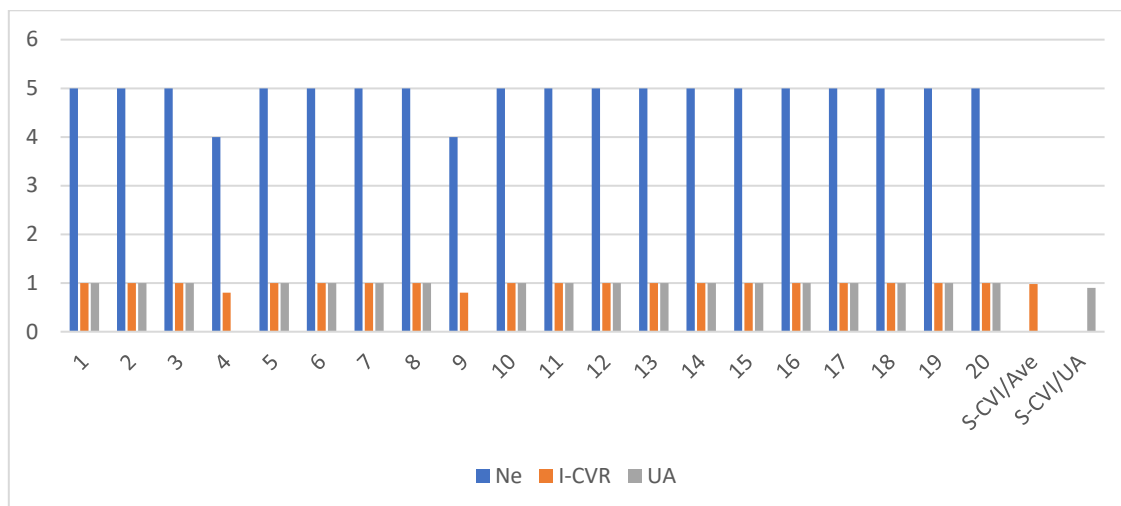


Figure 5. Results of i-CVI and s-CVI validation analysis by evaluation experts

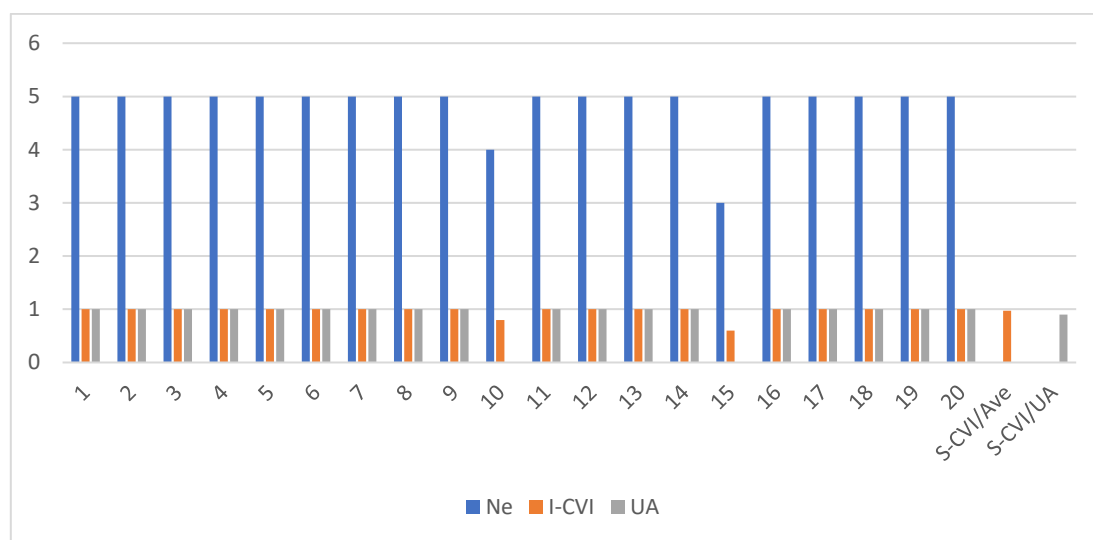


Figure 6. Results of i-CVI and s-CVI validation analysis validated by linguistics experts

Furthermore, it can be concluded that the developed teaching materials have a high level of validity and are classified as “very good,” because the i-CVI and s-CVI values lie within the range $0.80 < \text{Average i-CVI} < 1.00$ (Guilford & Fruchter, 1978).

Figures 1 to 6 present the validation data obtained from the six expert instruments. These instruments were completed by five experts in each of the following fields: media, mathematics, school mathematics, material, evaluation, and language. The item analysis of statements by media experts shows an i-CVI value of 0.8 for items 14 and 28, and 1.00 for all remaining items. The resulting s-CVI value is 0.99. The validity test by material experts yielded an i-CVI of 0.8 for questionnaire items 7, 15, 17, and 18, and 1.0 for all other items. The resulting s-CVI is 0.96. For mathematics experts, the i-CVI is 0.8 for items 4, 7, 9, and 15, and 1.0 for the remaining items, with an s-CVI of 0.97. School mathematics experts set an i-CVI of 0.8 for items 8 and 19, and 1.0 for all other items, resulting in an s-CVI of 0.98. Evaluation experts set an i-CVI of 0.8 for items 4 and 9, and 1.0 for all other items, with an s-CVI of 0.98. Finally, validation by linguistics experts yielded an i-CVI of 0.6 for item 15, 0.8 for item 10, and 1.0 for all other items.

Based on the i-CVI values calculated from all validators, the Geometry teaching materials are considered feasible and relevant, because they meet the minimum threshold of 1.00 (Polit & Beck, 2006; Polit et al., 2007). Furthermore, the statement items show i-CVI values within the range $0.80 < \text{Average}$

i-CVI < 1.00, indicating very high or very good validity (Guilford & Fruchter, 1978). While i-CVI values below 1.00 (specifically 0.6 and 0.8) are generally considered inadequate or irrelevant (Lynn, 1986; Polit et al., 2007), these particular values fall within the range $0.60 < \text{Average i-CVI} < 0.80$, which indicates high validity (Guilford & Fruchter, 1978). All s-CVI values obtained for the Geometry teaching materials exceed 0.90. This leads to the conclusion that all questionnaire items are feasible, relevant, and possess very high validity, because all s-CVI values are greater than 0.80 (Guilford & Fruchter, 1978; Lynn, 1986; Polit et al., 2007).

These content validity test results are consistent with previous studies that used the CVI approach for instrument validation, which produced valid values meeting the established threshold of 1.00, indicating feasibility, relevance, or very high validity (Bashoor & Supahar, 2018; Heryanto et al., 2019; Nursalam et al., 2017; Safitri et al., 2018; Santoso et al., 2016; Sugiharni, 2018; Puspitasari et al., 2021). Content validation of teaching materials is a necessary research procedure (Almanasreh et al., 2019) to ensure that these Geometry teaching materials are suitable for data collection and for the development of robust theory (Soares et al., 2021). Furthermore, the use of valid Geometry teaching materials can contribute to the improvement of research results (Rocha et al., 2020).

Although the materials have been declared valid by CVI analysis, their practical acceptability is demonstrated through a limited tryout and teacher feedback. The pilot was designed for two to three meetings in Grade VIII on polyhedra (prisms and pyramids), each meeting lasting two periods of forty minutes. The first meeting concentrated on connecting and organizing ideas in the CORE sequence, supported by Wingeom explorations of nets, cross sections, and surface–volume relationships. The subsequent meeting emphasized reflecting and extending through a real-world modeling task and short group presentations.

In practice, the teacher began by activating prior knowledge with a short quiz and guiding questions, then conducted a live Wingeom demonstration showing interactive manipulation—3D rotation, unfolding of nets, and measurement of edges and angles. Students worked in pairs in the computer lab using a prepared offline Wingeom package and completed worksheets that prompted observation, conjecture, and informal justification. Student products were uploaded to a class folder and discussed using a previously validated analytic rubric.

Implementation was supported by a teacher pack containing a step-by-step guide, question scripts, worksheet keys, turnkey Wingeom files, an offline alternative, and a readiness checklist for devices. The student pack provided structured worksheets, a CORE reflection sheet, and a short mini-project brief. In the limited tryout with two junior high mathematics teachers, both reported that setting up devices and opening Wingeom files was easy to very easy, with an average setup time of approximately six minutes. They found the CORE lesson flow clear and the time estimates realistic, and noted that the reflective discussion was facilitated by screenshots generated from Wingeom activities. The principal constraint was the need for a short orientation to Wingeom navigation for some students at the beginning of the first session and variation in computer specifications across schools. This was mitigated by a one-page quick-start guide and a lighter set of files for mid-range devices.

Teachers' qualitative comments converged on three themes. First, the visualization of nets and the surface–volume relationship helped students who typically struggle with spatial imagination to participate in discussion. Second, CORE-structured worksheets led students to articulate their own reasons rather than copy formulas. Third, while the time plan was realistic, the first session benefited from an additional five to ten minutes for device orientation. Teachers suggested adding one everyday context example to the Extending task and printing a small list of Wingeom hotkeys on the worksheet.

For the broader implementation, practical effectiveness will be monitored through attainment of lesson objectives, proportions of students completing worksheets, process metrics such as setup time and participation, short pre- and post-concept quizzes, quality of reasoning in reflection rubrics, and brief user-satisfaction surveys for teachers and students. With the teacher support pack, ready-to-use Wingeom files, and CORE-framed worksheets, the materials are classroom-ready with minimal adaptation. Preliminary usability and teacher feedback indicate that the CORE + Wingeom integration

is feasible, enhances engagement, and supports spatial understanding, with minor refinements centered on initial tool orientation and the inclusion of additional contextual examples.

4. CONCLUSION

The validation results across six expert domains—media (0.99), material (0.96), mathematics (0.96), school mathematics (0.98), evaluation (0.98), and language (0.97)—demonstrate that the geometry teaching materials developed using the CORE model and supported by Wingeom software exhibit very high content validity. These findings indicate that the materials are feasible, relevant, and appropriate for use as valid research instruments in mathematics learning for Grade VII junior high school students. However, this study is limited to content validity analysis and does not address other dimensions of validity. Therefore, future research should incorporate construct and criterion validity assessments to establish a more comprehensive evaluation of the teaching materials and further ensure their effectiveness and generalizability in broader educational settings.

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REFERENCES

- Afhami, A. H. (2022). Aplikasi GeoGebra Classic terhadap pemahaman konsep matematika siswa pada materi transformasi geometri. *Plusminus: Jurnal Pendidikan Matematika*, 2(3), 449–460.
- Ali, N. N., Lestari, P., & Rahayu, D. V. (2023). Kesulitan siswa SMP pada pembelajaran geometri materi bangun datar. *Plusminus: Jurnal Pendidikan Matematika*, 3(1), 139–146.
- Almanasreh, E., Moles, R., & Chen, T. F. (2019). Evaluation of methods used for estimating content validity. *Research in Social and Administrative Pharmacy*, 15(2), 214–221. <https://doi.org/10.1016/j.sapharm.2018.03.066>
- Angriani, A. D., Nursalam, N., Fuadah, N., & Baharuddin, B. (2018). Pengembangan instrumen tes untuk mengukur kemampuan pemecahan masalah matematika siswa. *AULADUNA: Jurnal Pendidikan Dasar Islam*, 5(2), 211–223.
- Barreto, A. C. F., & Rocha, D. S. (2020). Covid-19 e educação: Resistências, desafios e (im)possibilidades. *Revista Encantar*, 2, 1–11.
- Bashoor, K., & Supahar, S. (2018). Validitas dan reliabilitas instrumen asesmen kinerja literasi sains pelajaran fisika berbasis STEM. *Jurnal Penelitian dan Evaluasi Pendidikan*, 22(2), 219–230.
- Curwen, M. S., Miller, R. G., White-Smith, K. A., & Calfee, R. C. (2010). Increasing teachers' metacognition develops students' higher learning during content area literacy instruction: Findings from the Read-Write Cycle project. *Issues in Teacher Education*, 19(2), 127–151.
- Dick, W., & Carey, L. (1996). *The systematic design of instruction* (4th ed.). HarperCollins College Publishers.
- Fauziah, R., & Puspitasari, N. (2022). Kesulitan belajar matematika siswa SMA pada pokok bahasan persamaan trigonometri di Kampung Pasanggrahan. *Plusminus: Jurnal Pendidikan Matematika*, 2(2), 325–334.
- Guilford, J. P., & Fruchter, B. (1978). *Fundamental statistics in psychology and education* (6th ed.). McGraw-Hill.
- Gusnidar, Netriwati, & Putra, F. G. (2017). Implementasi strategi pembelajaran konflik kognitif

- berbantuan software Wingeom dalam meningkatkan kemampuan pemecahan masalah matematis. *JEMS: Jurnal Edukasi Matematika dan Sains*, 5(2), 62–69.
- Hakim, I. D., & Ramlah. (2020). Analisis kemampuan pemahaman konsep materi segitiga dan segiempat pada siswa SMP. *Prosiding Sesiomadika*, 2(1d).
- Hendryadi. (2017). Validitas isi: Tahap awal pengembangan kuesioner. *Jurnal Riset Manajemen dan Bisnis*, 2(2), 259–334.
- Hidayah, I. S., & Fitriani, N. (2021). Analisis kesulitan siswa SMP kelas VII dalam memahami materi segiempat dan segitiga dalam pembelajaran daring. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, 4(3), 631–642.
- Kurniasari, D., & Sritresna, T. (2022). Kesulitan pemecahan masalah matematis siswa berdasarkan self-esteem pada materi statistika. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 1(1), 47–56.
- Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing Research*, 35(6), 382–386.
- Meilina, A., Mariana, N., & Rahmawati, I. (2023). Implementasi LKPD PMRI dalam materi membilang sampai 20 untuk siswa fase A sekolah dasar. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 2(1), 45–54.
- Miller, R. G., & Calfee, R. C. (2004). *Building a better reading-writing assessment: Bridging cognitive theory, instruction, and assessment*.
- Nissa, I. C., Febrilia, B. R. A., & Pangga, D. (2023). Uji keterbacaan buku ajar matematika dasar untuk mahasiswa program studi pendidikan fisika. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 2(1), 1–8.
- Ole, A. A., & Dipan, E. G. (2023). Hubungan kondisi lingkungan belajar di sekolah dan hasil belajar siswa. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 2(1), 71–78.
- Pebrianti, W., & Puspitasari, N. (2023). Kemampuan pemahaman konsep pada materi sistem persamaan linear dua variabel ditinjau dari perbedaan gender siswa SMP. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 2(1), 55–70.
- Polit, D. F. (2016). *Research methodology: Effectiveness of sodium bicarbonate mouthwash in reducing oral mucositis among oral cancer patients receiving radiation therapy* (Unpublished thesis).
- Polit, D. F., Beck, C. T., & Owen, S. V. (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Research in Nursing & Health*, 30(4), 459–467.
- Purwanto. (2008). *Evaluasi hasil belajar*. Pustaka Belajar.
- Puspitasari, H., Wilujeng, I., & Haristy, D. R. (2021). Keefektifan interactive e-book IPA untuk meningkatkan kemampuan literasi sains siswa SMP pada masa pandemi Covid-19. *Al Ulum: Jurnal Sains dan Teknologi*, 6(2), 49–55.
- Ramdhani, S. (2017). Pengembangan media pembelajaran konsep luas bidang datar berbasis perangkat lunak GeoGebra. *Jurnal Edukasi dan Sains Matematika (JES-MAT)*, 3(2), 95–110.
- Ristian, A., & Maryati, I. (2022). Kemampuan representasi matematis dan self-esteem siswa pada materi statistika. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 1(1), 37–46.
- Safitri, D. D. (2018). Managing school based on character building in the context of religious school culture (Case in Indonesia). *Journal of Social Studies Education Research*, 9(4), 274–294.
- Santoso, H. B., Schrepp, M., Isal, R. Y. K. I., Utomo, A. Y., & Priyogi, B. (2016). Measuring user experience of the student-centered e-learning environment. *Journal of Educators Online*, 13(1), 58–79.
- Sholihah, S. Z., & Afriansyah, E. A. (2017). Analisis kesulitan siswa dalam proses pemecahan masalah geometri berdasarkan tahapan berpikir Van Hiele. *Mosharafa: Jurnal Pendidikan Matematika*, 6(2), 287–298.
- Soares, P., Rocha, J. V., Moniz, M., Gama, A., Laires, P. A., Pedro, A. R., ... Nunes, C. (2021). Factors associated with COVID-19 vaccine hesitancy. *Vaccines*, 9(3), 300. <https://doi.org/10.3390/vaccines9030300>
- Sofiani, J., Nurjamil, D., & Nurhayati, E. (2023). Kemampuan penalaran analogi ditinjau dari self-

- concept. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 2(1), 17–30.
- Sugiharni, G. A. D. (2018). Pengujian validitas konten media pembelajaran interaktif berorientasi model creative problem solving. *Jurnal Penelitian dan Pengembangan Pendidikan*, 2(2), 88–95.
- Sugiyono. (2016). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.
- Sumiati, A., & Agustini, Y. (2020). Analisis kesulitan menyelesaikan soal segiempat dan segitiga siswa SMP kelas VIII di Cianjur. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 4(1), 321–331.
- Ulfa, N. C. A., & Sundayana, R. (2022). Kemampuan representasi matematis siswa pada materi bilangan berdasarkan self-confidence. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 1(2), 193–200.
- Ulkhag, M. M. (2023). Determinan pencapaian siswa bidang matematika: Perbandingan antara Indonesia dan Singapura. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 2(1), 9–16.
- Wulandari, R., Suwanto, S., & Novaliyosi. (2021). Analisis pembelajaran daring dengan model discovery learning pada materi geometri ruang. *Wilangan: Jurnal Inovasi dan Riset Pendidikan Matematika*, 2(3), 132–140.