# STAKEHOLDER PRIORITIZATION OF MATHEMATICS TEXTBOOK QUALITY DIMENSIONS USING THE ANALYTICAL HIERARCHY PROCESS

**Kennet G. Cuarteros**

University of Science and Technology of Southern Philippines, Lapasan Highway, Cagayan de Oro City, Philippines

*For Correspondence; Tel. +639176774482, Email: kennet.cuarteros@ustp.edu.ph

Date of Publication: 29 July, 2026

*ABSTRACT: The quality of mathematics textbooks plays a critical role in facilitating meaningful learning, particularly in conceptually demanding subjects such as Basic Calculus. However, textbook evaluation often involves multiple interrelated dimensions, making it difficult to determine which characteristics should be prioritized in the development and selection of instructional materials. The study employed the Analytical Hierarchy Process (AHP), a multi-criteria decision-making approach, to determine the relative importance of eight textbook quality dimensions from the perspectives of Senior High School students and mathematics teachers. The dimensions evaluated were structure and layout, knowledge development, mathematical design and task characteristics, language use, mathematical discourse, Gender and Development (GAD) integration, multiple intelligences, and cultural integration. Pairwise comparison questionnaires based on Saaty's fundamental scale were administered to 20 Senior High School students and 16 mathematics teachers from selected schools in Cagayan de Oro City, Philippines. Priority weights were computed using the eigenvector method, and judgment consistency was verified through the Consistency Ratio (CR), with all matrices satisfying the acceptable threshold of CR < 0.10. The results revealed that both stakeholder groups identified knowledge development as the most important textbook dimension, followed by mathematical design and task characteristics and structure and layout, underscoring the importance of coherent concept progression, well-designed mathematical tasks, and organized presentation in supporting calculus learning. In contrast, Gender and Development integration and cultural integration received the lowest priority weights, although they remained recognized components of quality instructional materials. The findings demonstrate the applicability of AHP as a systematic and reliable approach for prioritizing textbook evaluation criteria and provide empirical evidence that can guide curriculum developers, textbook authors, educators, and policymakers in designing and selecting mathematics textbooks that better address stakeholder priorities and promote effective mathematics instruction.*

**Keywords:** Analytical Hierarchy Process, mathematics textbook evaluation, Basic Calculus, multi-criteria decision making, mathematics education, instructional materials

## 1. INTRODUCTION

Mathematics textbooks remain one of the most influential instructional resources in formal education, serving as the primary medium through which curriculum objectives are translated into classroom practice. Beyond presenting mathematical content, textbooks organize the sequence of concepts, provide worked examples, design learning tasks, and shape opportunities for reasoning, problem-solving, and mathematical communication. Consequently, the quality of mathematics textbooks has a direct influence on students' conceptual understanding, teachers' instructional decisions, and the overall effectiveness of curriculum implementation. Recent studies have increasingly recognized textbooks as curriculum resources that mediate teaching and learning rather than merely repositories of mathematical knowledge [1-5].

The importance of high-quality instructional materials is particularly evident in Senior High School Basic Calculus, where learners encounter abstract concepts such as limits, continuity, and derivatives. These concepts require carefully sequenced explanations, meaningful mathematical tasks, and coherent connections between prior and new knowledge. Research has shown that many students experience difficulties in calculus because of inadequate conceptual development, overly procedural instruction, and insufficient opportunities to engage in higher-order mathematical thinking. Poorly designed textbooks characterized by dense presentations, disconnected examples, and limited conceptual scaffolding may further contribute to these learning challenges [3, 6, 7].

Evaluating mathematics textbooks, however, is inherently a multi-dimensional process. Contemporary frameworks emphasize that textbook quality extends beyond content accuracy to include structural organization, knowledge development, mathematical task design, language clarity, opportunities for mathematical discourse, and inclusive features such as Gender and Development (GAD), cultural integration, and multiple intelligences. These dimensions are likewise emphasized in contemporary curriculum and educational policy frameworks promoting equitable and inclusive learning environments [15, 16]. These dimensions collectively influence learners' opportunities to construct mathematical understanding and engage meaningfully with instructional materials [4]. Because these characteristics vary in importance depending on stakeholder perspectives, determining their relative priority remains a significant challenge in textbook evaluation.

Traditional textbook evaluation approaches commonly employ descriptive rating scales, checklist methods, or qualitative reviews that assess the presence of instructional characteristics. While these approaches effectively describe textbook features, they generally assume that all evaluation criteria contribute equally to textbook quality. In practice, however, educators and learners often value certain dimensions more than others. For example, coherent knowledge progression may be considered more essential than physical appearance, while well-designed mathematical tasks may be prioritized over contextual illustrations. Without a systematic method for quantifying these preferences, textbook evaluation may overlook the relative importance of individual quality dimensions.

The Analytical Hierarchy Process (AHP), developed by Saaty, provides a structured multi-criteria decision-making approach for addressing complex evaluation problems involving multiple competing criteria. Through systematic pairwise comparisons, AHP converts subjective judgments into quantitative priority weights while simultaneously evaluating the logical consistency of respondents' decisions using the Consistency Ratio (CR). The method has been widely applied in educational decision-making, curriculum evaluation, instructional quality assessment, and resource allocation because it allows complex educational issues to be decomposed into manageable components and objectively prioritized [8-13].

Recent educational studies have demonstrated the usefulness of AHP in evaluating instructional systems, learning environments, teaching quality, and educational resources. Nevertheless, relatively few studies have applied AHP to determine stakeholder priorities regarding the quality dimensions of mathematics textbooks, particularly in the context of Senior High School Basic Calculus in the Philippines. Existing investigations on mathematics textbooks largely focus on descriptive analyses of textbook characteristics or comparisons of instructional materials, with limited attention given to establishing empirically derived priority weights that reflect the perspectives of actual textbook users. This gap limits the development of evidence-based evaluation criteria that can guide textbook selection, curriculum improvement, and instructional material development [4, 5].

To address this gap, the present study employed the Analytical Hierarchy Process to determine the relative importance of eight dimensions of mathematics textbook quality: structure and layout, knowledge development, mathematical design and task characteristics, language use, mathematical discourse, Gender and Development (GAD) integration, multiple intelligences, and cultural integration. Pairwise comparisons obtained from Senior High School students and mathematics teachers were analyzed to generate normalized priority weights and consistency measures. By identifying the dimensions considered most important by key stakeholders, the study provides empirical evidence that can support curriculum developers, textbook authors, educators, and policymakers in designing, evaluating, and selecting mathematics textbooks that better respond to instructional needs and learner expectations.

The findings also demonstrate the applicability of the Analytical Hierarchy Process as a robust methodological framework for multi-criteria evaluation in mathematics education. Beyond establishing stakeholder priorities, the study contributes to the growing body of research on evidence-based textbook evaluation by illustrating how quantitative decision-making techniques can strengthen educational assessment and improve the quality of instructional materials in support of evidence-informed curriculum development and effective educational resource utilization [17].

## 2. METHODOLOGY

### 2.1 Research Design

This study employed a descriptive cross-sectional research design using the Analytical Hierarchy Process (AHP), a multi-criteria decision-making (MCDM) technique developed by Saaty [8], to determine the relative importance of mathematics textbook quality dimensions from the perspectives of Senior High School students and mathematics teachers. AHP was selected because textbook quality is a multidimensional construct consisting of several interrelated instructional characteristics that require systematic prioritization. Unlike conventional descriptive rating approaches, AHP quantifies subjective judgments through pairwise comparisons while assessing the logical consistency of respondents' decisions using the Consistency Ratio (CR) as demonstrated in educational decision-making studies [9]-[13]. This approach provides an objective basis for ranking evaluation criteria according to stakeholder preferences.

The study focused on eight dimensions of mathematics textbook quality identified from contemporary literature on mathematics textbook evaluation: (1) Structure and Layout, (2) Knowledge Development, (3) Mathematical Design and Task Characteristics, (4) Language Use, (5) Mathematical Discourse, (6) Gender and Development (GAD) Integration, (7) Multiple Intelligences, and (8) Cultural Integration. These dimensions constituted the evaluation criteria in the AHP hierarchy.

### 2.2 Participants

The study involved 36 respondents, comprising 20 Senior High School students enrolled in the Science, Technology, Engineering, and Mathematics (STEM) strand and 16 Senior High School mathematics teachers teaching Basic Calculus in selected public, private, laboratory, and science high schools in Cagayan de Oro City, Philippines. Participants were selected using purposive sampling to ensure that all respondents had direct experience in using Senior High School Basic Calculus textbooks.

Student participants represented diverse educational settings to capture a broad range of learner perspectives, while teacher participants consisted of all available Basic Calculus teachers from the participating schools during the conduct of the study. The inclusion of both stakeholder groups enabled comparisons between learner and teacher priorities regarding textbook quality.

### 2.3 Development of the AHP Criteria

The criteria used in the AHP model were derived from established international frameworks on mathematics textbook evaluation and curriculum resource research. Eight dimensions representing essential characteristics of quality mathematics textbooks were identified through an extensive review of literature.

The dimensions included:

1. Structure and Layout
2. Knowledge Development

3. Mathematical Design and Task Characteristics
4. Language Use
5. Mathematical Discourse
6. Gender and Development (GAD) Integration
7. Multiple Intelligences
8. Cultural Integration

These dimensions formed the second level of the AHP hierarchy, with the overall goal of determining the relative importance of textbook quality dimensions occupying the first level.

**2.4 Research Instrument**

Data were collected using a researcher-developed Analytical Hierarchy Process Pairwise Comparison Questionnaire. The instrument required respondents to compare every possible pair of textbook quality dimensions using Saaty's nine-point fundamental scale, where a value of 1 indicated equal importance and a value of 9 indicated extreme importance of one criterion over another.

Because eight criteria were evaluated, each respondent completed 28 pairwise comparisons, corresponding to the number of unique criterion pairs:

$$\frac{n(n-1)}{2}$$

where *n=8*, resulting in *28* pairwise judgments per respondent.

Prior to data collection, the instrument underwent face and content validation by experts in mathematics education and educational research to ensure clarity, relevance, and alignment with the objectives of the study. Recommendations from the validators were incorporated before the final administration of the questionnaire.

**2.5 Data Collection Procedure**

Permission to conduct the study was obtained from the administrators of participating schools before data collection. Written informed consent was secured from all respondents, and parental consent was obtained for student participants whenever required by institutional policies.

Before completing the pairwise comparison questionnaire, respondents attended a short orientation on the Analytical Hierarchy Process. During the orientation, the researcher explained the purpose of the study, the meaning of each textbook quality dimension, the concept of pairwise comparison, and the interpretation of Saaty's fundamental scale. Sample comparisons were provided to ensure that participants fully understood the evaluation process.

The questionnaires were administered individually under the supervision of the researcher. Completed instruments were checked for completeness before data encoding and analysis.

**2.6 Analytical Hierarchy Process**

The Analytical Hierarchy Process was implemented following the procedure proposed by Saaty [9]. Recent developments have further extended AHP to address uncertainty and improve decision-making robustness while maintaining its fundamental principles of pairwise comparison and priority derivation [14].

**Step 1. Construction of Pairwise Comparison Matrices**

Separate pairwise comparison matrices were constructed for students and teachers using the geometric mean of individual responses. Each element aija_{ij}aij represented the relative importance of criterion iii over criterion jjj, while reciprocal values satisfied

$$a_{ji} = \frac{1}{a_{ij}}$$

Diagonal elements were assigned a value of one.

**Step 2. Normalization of the Matrix**

Each matrix was normalized by dividing every element by the sum of its corresponding column:

$$n_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

where

$a_{ji}$ denotes the pairwise comparison value,
$n_{ij}$ is the normalized value, and
$n$ is the number of criteria.

**Step 3. Computation of Priority Weights**

Priority weights were obtained by averaging the normalized values across each row:

$$w_i = \frac{1}{n}\sum_{j=1}^{n} n_{ij}$$

where $w_i$ represents the priority weight of criterion $i$.

The resulting weights indicate the relative importance assigned by respondents to each textbook quality dimension.

**Step 4. Consistency Assessment**

The consistency of respondents' judgments was evaluated by computing the maximum eigenvalue (λmax), Consistency Index (CI), and Consistency Ratio (CR) following the recommendations of Brunelli [10] and Saaty and Vargas [13].

The Consistency Index was computed as

$$CI = \frac{\lambda_{max} - n}{n-1}$$

The Consistency Ratio was calculated using

$$CR = \frac{CI}{RI}$$

where

*RI* is Saaty's Random Index corresponding to the number of criteria.

A matrix was considered acceptable when

$$CR < 0.10$$

indicating satisfactory logical consistency of judgments.

**Step 5. Ranking of Criteria**

The computed priority weights were arranged in descending order to determine the relative importance of the eight textbook quality dimensions. Separate rankings were generated for students and teachers to facilitate comparison between stakeholder groups.

**Step 6. Spearman's Rank Correlation Analysis**

To determine the degree of agreement between the rankings generated by Senior High School students and mathematics teachers, Spearman's rank-order correlation coefficient (ρ) was computed using the final AHP rankings of the eight textbook quality dimensions. Spearman's correlation is a nonparametric measure of the strength and direction of association between two ranked variables and is appropriate for ordinal data produced through the Analytical Hierarchy Process. The coefficient ranges from −1 to +1, where values closer to +1 indicate stronger positive agreement between rankings. Statistical significance was evaluated at the 5%

level of significance ($\alpha$ = 0.05). A statistically significant positive coefficient indicates that the two stakeholder groups exhibited similar preferences in prioritizing mathematics textbook quality dimensions.

### 2.7 Ethical Considerations

The study adhered to established ethical principles governing educational research. Participation was entirely voluntary, and respondents were informed of the objectives of the study before completing the questionnaire. Participants were assured that their identities would remain confidential and that all responses would be used solely for academic research purposes. No personally identifiable information was included in the analysis, and respondents were free to withdraw from the study at any stage without penalty.

## 3. RESULTS

### Priority Weights of Mathematics Textbook Quality Dimensions Among Senior High School Students

The Analytical Hierarchy Process (AHP) was employed to determine the relative importance assigned by Senior High School students to the eight dimensions of mathematics textbook quality. The resulting priority weights, normalized from the pairwise comparison matrices, are presented in Table 3.1. The consistency ratio (CR) of **0.099** was below the acceptable threshold of 0.10, indicating that the respondents' judgments were logically consistent and suitable for priority analysis.

**Table 3.1. Priority Weights of Mathematics Textbook Quality Dimensions According to Senior High School Students**

| Dimension | Priority Weight | Rank |
|---|---|---|
| Knowledge Development | 0.343 | 1 |
| Structure and Layout | 0.226 | 2 |
| Mathematical Design and Task Characteristics | 0.213 | 3 |
| Mathematical Discourse | 0.077 | 4 |
| Multiple Intelligences | 0.049 | 5 |
| Language Use | 0.044 | 6 |
| Cultural Integration | 0.030 | 7 |
| Gender and Development (GAD) Integration | 0.018 | 8 |

**Consistency Ratio (CR) = 0.099**

Knowledge Development obtained the highest priority weight (0.343), representing approximately one-third of the total decision weight assigned by the students. Structure and Layout (0.226) and Mathematical Design and Task Characteristics (0.213) ranked second and third, respectively. The remaining dimensions collectively accounted for less than one-fourth of the total priority weight, with Gender and Development (GAD) Integration receiving the lowest weight (0.018).

### Priority Weights of Mathematics Textbook Quality Dimensions Among Mathematics Teachers

The relative priorities assigned by mathematics teachers are summarized in Table 3.2. The resulting pairwise comparison matrix yielded a Consistency Ratio of 0.095, demonstrating acceptable consistency according to Saaty's criterion.

**Table 3.2. Priority Weights of Mathematics Textbook Quality Dimensions According to Mathematics Teachers**

| Dimension | Priority Weight | Rank |
|---|---|---|
| Knowledge Development | 0.295 | 1 |
| Mathematical Design and Task Characteristics | 0.261 | 2 |
| Structure and Layout | 0.220 | 3 |
| Language Use | 0.076 | 4 |
| Multiple Intelligences | 0.062 | 5 |
| Mathematical Discourse | 0.046 | 6 |
| Cultural Integration | 0.021 | 7 |
| Gender and Development (GAD) Integration | 0.020 | 8 |

**Consistency Ratio (CR) = 0.095**

Knowledge Development emerged as the most important textbook dimension among teachers, accounting for 29.5% of the overall priority weight. Mathematical Design and Task Characteristics (0.261) ranked second, followed by Structure and Layout (0.220). Similar to the student group, GAD Integration (0.020) and Cultural Integration (0.021) obtained the lowest priority weights.

### Comparison of Students' and Teachers' Priority Rankings

A comparison of stakeholder priorities is presented in Table 3.3. Both students and teachers identified Knowledge Development as the highest-ranked dimension, indicating complete agreement on the most essential characteristic of a quality mathematics textbook.

**Table 3.3. Comparison of Priority Weights Between Students and Teachers**

| Dimension | Students | Teachers | Student Rank | Teacher Rank |
|---|---|---|---|---|
| Knowledge Development | 0.343 | 0.295 | 1 | 1 |
| Structure and Layout | 0.226 | 0.220 | 2 | 3 |
| Mathematical Design and Task Characteristics | 0.213 | 0.261 | 3 | 2 |
| Language Use | 0.044 | 0.076 | 6 | 4 |
| Mathematical Discourse | 0.077 | 0.046 | 4 | 6 |
| Multiple Intelligences | 0.049 | 0.062 | 5 | 5 |
| Cultural Integration | 0.030 | 0.021 | 7 | 7 |
| Gender and Development (GAD) Integration | 0.018 | 0.020 | 8 | 8 |

The ranking patterns between the two stakeholder groups showed substantial similarity. Both groups consistently assigned the three highest priorities to Knowledge Development, Mathematical Design and Task Characteristics, and Structure and Layout, although the order of the latter two dimensions differed slightly. Likewise, both groups assigned the lowest priorities to Cultural Integration and Gender and Development (GAD) Integration. Differences were observed in the relative emphasis placed on Language Use and Mathematical Discourse, with teachers assigning greater importance to Language Use, while students gave relatively higher priority to Mathematical Discourse.

### Spearman's Rank Correlation Between Students' and Teachers' Priority Rankings

To further determine the degree of agreement between the priority rankings assigned by Senior High School students and mathematics teachers, Spearman's rank-order correlation coefficient was computed using the ranks presented in Table 3.3. Spearman's rank-order correlation was employed because the AHP generated ordinal rankings of textbook quality dimensions. The analysis provides statistical evidence on whether the two stakeholder groups exhibited similar preferences in prioritizing textbook quality dimensions.

**Table 3.4. Spearman's Rank Correlation Between Students' and Teachers' Priority Rankings**

| Variables Compared | Spearman's ρ | p-value | Interpretation |
|---|---|---|---|
| Students' and Teachers' Priority Rankings | 0.881 | 0.0039 | Significant |

**Decision Rule:** Reject the null hypothesis if $p < 0.05$.

The analysis revealed a strong positive correlation between the rankings assigned by students and teachers ($\rho = 0.881$, $p = 0.0039$). The statistically significant result indicates that both stakeholder groups demonstrated a high level of agreement regarding the relative importance of mathematics textbook quality dimensions. Although minor differences were observed in the ordering of Structure and Layout, Mathematical Design and Task Characteristics, Language Use, and Mathematical Discourse, the overall ranking patterns remained highly consistent. This finding further validates the priority weights generated through the Analytical Hierarchy Process and suggests that the resulting rankings provide a stable representation of stakeholder preferences.

**Overall Priority of Mathematics Textbook Quality Dimensions**

The comparison of stakeholder priorities demonstrates a common pattern in the evaluation of mathematics textbooks. Knowledge Development consistently received the highest priority from both respondent groups, while Mathematical Design and Task Characteristics and Structure and Layout occupied the next highest positions. Collectively, these three dimensions accounted for more than 75% of the total decision weight for both students and teachers, indicating that stakeholders primarily considered the organization and presentation of mathematical concepts as the defining characteristics of quality Basic Calculus textbooks.

Conversely, Language Use, Mathematical Discourse, Multiple Intelligences, Cultural Integration, and Gender and Development (GAD) Integration received comparatively lower priority weights. Although these dimensions contributed less to the overall prioritization, they remained integral components of the multidimensional framework for evaluating mathematics textbooks. The acceptable Consistency Ratios obtained from both respondent groups further indicate that the priority weights generated through the Analytical Hierarchy Process provide reliable and internally consistent representations of stakeholder judgments.

## 4. DISCUSSION

The present study employed the Analytical Hierarchy Process (AHP) to determine the relative importance of eight dimensions of mathematics textbook quality from the perspectives of Senior High School students and mathematics teachers. The acceptable Consistency Ratios obtained for both students (CR = 0.099) and teachers (CR = 0.095) indicate that the pairwise judgments were logically consistent, demonstrating the reliability of the priority weights generated through the AHP. These findings confirm the suitability of AHP as a structured multi-criteria decision-making approach for evaluating educational resources involving multiple and interrelated dimensions.

The results revealed that Knowledge Development received the highest priority from both students and teachers, indicating a shared belief that the effectiveness of a mathematics textbook primarily depends on how mathematical concepts are introduced, sequenced, and connected. This finding reflects the cumulative nature of mathematics learning, particularly in Basic Calculus, where understanding advanced concepts requires strong conceptual foundations. Well-organized progression from prerequisite knowledge to more complex ideas enables learners to construct meaningful mathematical understanding rather than relying solely on memorization or procedural manipulation. The prominence of Knowledge Development is consistent with constructivist learning theory, which emphasizes that learners actively build new knowledge upon existing cognitive structures through carefully sequenced learning experiences. It also supports previous studies identifying coherent content progression as one of the most influential characteristics of effective mathematics textbooks. This finding supports Fan et al. [5], who argued that coherent content progression remains one of the defining characteristics of high-quality mathematics textbooks.

Although both stakeholder groups agreed on the importance of Knowledge Development, slight differences emerged in the prioritization of the succeeding dimensions. Students ranked Structure and Layout second, whereas teachers assigned the second highest priority to Mathematical Design and Task Characteristics. This difference may reflect the distinct roles of learners and teachers during textbook use. Students interact directly with the physical organization of textbooks, making readability, visual presentation, and logical arrangement important factors that influence motivation and comprehension. Teachers, on the other hand, are more concerned with the instructional value of mathematical tasks because these activities determine students' opportunities to develop reasoning, problem-solving skills, and conceptual understanding. Such differences illustrate how stakeholder roles influence perceptions of instructional quality while maintaining agreement on the fundamental characteristics of effective mathematics textbooks. Similar observations have been reported by Fan *et al.* [4, 5], where teachers placed greater emphasis on pedagogical organization than students.

The high priority assigned to Mathematical Design and Task Characteristics by both groups further emphasizes the importance of meaningful mathematical activities in calculus instruction. Well-designed tasks promote conceptual reasoning, encourage multiple solution strategies, and provide opportunities for learners to connect mathematical ideas with authentic situations. Contemporary mathematics education research consistently argues that instructional tasks should extend beyond routine computational exercises to include cognitively demanding activities that foster reasoning, communication, and problem solving. The present findings therefore support recommendations that textbook developers should prioritize task quality alongside content organization when designing instructional materials. This supports the findings of Sievert et al. [14], who demonstrated that textbook quality contributes to mathematics learning opportunities.

Interestingly, Language Use, Mathematical Discourse, and Multiple Intelligences received moderate priority weights. Teachers assigned relatively greater importance to Language Use than students, possibly because teachers recognize that precise mathematical terminology and carefully constructed explanations reduce misconceptions and facilitate classroom instruction. Students, meanwhile, placed relatively greater emphasis on Mathematical Discourse, suggesting that opportunities to explain ideas, justify solutions, and communicate mathematical reasoning contribute positively to their learning experiences. These differences highlight the complementary perspectives of teachers and learners regarding effective mathematics instruction and suggest that future textbook development should integrate clear language with activities that encourage mathematical communication. The importance of clear mathematical language has likewise been emphasized by O'Keeffe and O'Donoghue [3].

The lowest priority weights were consistently assigned to Gender and Development (GAD) Integration and Cultural Integration by both respondent groups. While these dimensions were perceived as less influential than cognitive and pedagogical characteristics, this finding should not be interpreted as indicating that inclusivity is unimportant. Instead, it suggests that when stakeholders evaluate textbooks for conceptually demanding subjects such as Basic Calculus, they naturally prioritize dimensions that directly affect conceptual understanding and problem-solving performance. Inclusive features may be viewed as complementary rather than primary criteria during textbook evaluation. Nevertheless, current educational policies emphasize that mathematics instructional materials should remain responsive to diverse learners through equitable representation, culturally meaningful contexts, and gender-sensitive examples. Consequently, these dimensions should continue to be incorporated into textbook design despite receiving lower priority weights. Contemporary curriculum reforms likewise encourage culturally responsive and inclusive instructional materials [15], [16].

The substantial agreement between students and teachers demonstrates that the fundamental expectations of quality mathematics textbooks are largely shared across stakeholder groups. Both groups consistently identified Knowledge Development, Mathematical Design and Task Characteristics, and Structure and Layout as the three most important dimensions. This convergence strengthens the validity of the derived priority weights and suggests that these dimensions should receive greater emphasis during textbook evaluation, selection, and development. The consistency of stakeholder priorities also indicates that improvements targeting these core dimensions are likely to benefit both teaching effectiveness and student learning.

To statistically verify the observed similarity in stakeholder priorities, Spearman's rank-order correlation analysis was performed. The resulting coefficient ($\rho = 0.881$, $p = 0.0039$) confirmed a strong and statistically significant positive association between the rankings assigned by students and teachers. This finding indicates that despite differences in their educational roles, both stakeholder groups share remarkably similar perceptions regarding the characteristics of high-quality mathematics textbooks. Such convergence enhances the credibility of the AHP-derived priority weights and demonstrates that the identified priorities are robust across different stakeholder perspectives.

The strong agreement also reinforces the applicability of the Analytical Hierarchy Process as a decision-support tool in educational evaluation. Since both students and teachers independently prioritized Knowledge Development, Mathematical Design and Task Characteristics, and Structure and Layout as the three most important dimensions, curriculum developers and textbook authors can confidently emphasize these characteristics during textbook development and revision. The statistical agreement further suggests that the derived priorities are not merely group-specific opinions but represent shared expectations regarding effective mathematics instructional materials.

From a methodological perspective, the study demonstrates the value of the Analytical Hierarchy Process in educational evaluation. Traditional textbook evaluation often relies on descriptive checklists or qualitative judgments that implicitly assume equal importance among evaluation criteria. In contrast, AHP enables stakeholders to express relative preferences through systematic pairwise comparisons, producing quantitative priority weights while simultaneously verifying the logical consistency of their judgments. This capability provides curriculum developers and policymakers with evidence-based priorities that can support more transparent and defensible decisions regarding textbook selection and instructional material development. Similar advantages of AHP over traditional decision-making approaches have been extensively discussed by Ishizaka and Labib [12], Brunelli [10], and Saaty and Vargas [13].

Overall, the findings suggest that mathematics textbook quality is primarily determined by how effectively textbooks develop mathematical knowledge, organize instructional content, and provide meaningful learning tasks. Although other dimensions such as language, discourse, inclusivity, and cultural responsiveness remain important components of comprehensive textbook quality, they appear to function as supporting characteristics rather than primary determinants of stakeholders' evaluations. The application of the Analytical Hierarchy Process therefore provides a robust framework for identifying educational priorities and contributes to the growing body of research advocating evidence-based approaches to instructional material evaluation.

**Practical Implications**

The findings provide empirical guidance for textbook authors, curriculum developers, publishers, and policymakers by identifying Knowledge Development, Mathematical Design and Task Characteristics, and Structure and Layout as the highest priorities during textbook evaluation and development. These priorities may also serve as evidence-based criteria in textbook review, curriculum revision, and instructional material selection at both the institutional and national levels.

**Limitations**

The study was limited to selected schools in Cagayan de Oro City using purposive sampling and focused exclusively on Senior High School Basic Calculus. Consequently, the findings may not be generalizable to other mathematics subjects or educational contexts. Future investigations should include larger and more diverse samples from different regions, curriculum experts, textbook authors, and policymakers to validate and extend the proposed priority framework.

## 5. CONCLUSION

This study demonstrated the applicability of the Analytical Hierarchy Process (AHP) as a systematic and reliable multi-criteria decision-making approach for determining the relative importance of mathematics textbook quality dimensions from the perspectives of Senior High School students and mathematics teachers. The acceptable Consistency Ratios obtained for both stakeholder groups confirmed the logical consistency of their pairwise judgments, validating the reliability of the AHP-derived priority weights. Furthermore, the Spearman's rank correlation analysis revealed a strong and statistically significant positive correlation between the rankings of students and teachers ($\rho = 0.881$, $p = 0.0039$), providing empirical evidence of a high level of agreement in their prioritization of mathematics textbook quality dimensions.

The findings consistently identified Knowledge Development as the most important dimension of mathematics textbook quality, followed by Mathematical Design and Task Characteristics and Structure and Layout. These results underscore the importance of coherent concept progression, meaningful mathematical tasks, and well-organized instructional content in supporting effective teaching and learning of Basic Calculus. Conversely, Gender and Development (GAD) Integration and Cultural Integration received the lowest priority weights, suggesting that although inclusivity remains an essential component of quality instructional materials, stakeholders place greater emphasis on dimensions that directly influence conceptual understanding and mathematical learning.

The strong agreement between students and teachers strengthens the credibility of the priority weights generated through the Analytical Hierarchy Process and indicates that these priorities are robust across key stakeholder groups. Therefore, the results provide a reliable and evidence-based foundation for textbook evaluation, development, and selection. The priority weights established in this study may serve as valuable references for textbook authors, curriculum developers, educators, publishers, and policymakers in designing instructional materials that better align with stakeholder expectations and promote meaningful mathematics learning.

Overall, this study contributes to the growing body of research on evidence-based mathematics textbook evaluation by integrating the Analytical Hierarchy Process with statistical validation of stakeholder agreement. The proposed framework offers a transparent, systematic, and replicable approach that can be adapted to evaluate instructional materials across other mathematics disciplines and educational contexts, thereby supporting more informed and defensible educational decision-making. The findings are likewise consistent with recent international studies on mathematics textbooks and curriculum development [5, 18].

Future applications of this framework may extend to other mathematics subjects and educational levels, thereby supporting more systematic and evidence-based textbook evaluation.

## Acknowledgement

The author gratefully acknowledges the Department of Science and Technology–Science Education Institute (DOST-SEI), Philippines, for the scholarship support provided through the Scholarships for Research and Development Toward Sustainable Development (STRAND) Program. The financial assistance and academic support extended by DOST-SEI significantly contributed to the successful completion of this study.

## REFERENCES

[1] L. Fan, "Textbook research as scientific research: Towards a common ground on issues and methods of research on mathematics textbooks," *ZDM Mathematics Education*, vol. 45, no. 5, pp. 765–777, 2013. doi:10.1007/s11858-013-0530-6.

[2] L. Fan, Y. Zhu, and Z. Miao, "Textbook research in mathematics education: Development status and directions," *ZDM Mathematics Education*, vol. 45, no. 5, pp. 633–646, 2013. doi:10.1007/s11858-013-0539-x.

[3] L. O'Keeffe and J. O'Donoghue, "A role for language analysis in mathematics textbook analysis," *International Journal of Science and Mathematics Education*, vol. 13, no. 3, pp. 605–630, 2015. doi:10.1007/s10763-013-9463-3.

[4] L. Fan, L. Trouche, C. Qi, S. Rezat, and J. Visnovska, Eds., *Research on Mathematics Textbooks and Teachers' Resources: Advances and Issues*. Cham, Switzerland: Springer, 2018.

[5] L. Fan, C. Qi, W. T. Seah, and Q. Liu, "Research on mathematics textbooks in relation to curriculum development and instructional reform: Recent advances and future directions," *ZDM–Mathematics Education*, vol. 57, no. 5, pp. 845–857, 2025. doi:10.1007/s11858-025-01736-6.

[6] Organisation for Economic Co-operation and Development (OECD), *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*. Paris, France: OECD Publishing, 2023. doi:10.1787/53f23881-en.

[7] I. V. S. Mullis, M. O. Martin, P. Foy, D. L. Kelly, and B. Fishbein, *TIMSS 2019 International Results in Mathematics and Science*. Chestnut Hill, MA, USA: TIMSS & PIRLS International Study Center, Boston College, 2020.

[8] T. L. Saaty, *The Analytic Hierarchy Process*. New York, NY, USA: McGraw-Hill, 1980.

[9] T. L. Saaty, "Decision making with the Analytic Hierarchy Process," *International Journal of Services Sciences*, vol. 1, no. 1, pp. 83–98, 2008. doi:10.1504/IJSSCI.2008.017590.

[10] M. Brunelli, *Introduction to the Analytic Hierarchy Process*. Cham, Switzerland: Springer, 2015.

[11] E. H. Forman and S. I. Gass, "The Analytic Hierarchy Process—An exposition," *Operations Research*, vol. 49, no. 4, pp. 469–486, 2001. doi:10.1287/opre.49.4.469.11231.

[12] A. Ishizaka and A. Labib, "Review of the main developments in the Analytic Hierarchy Process," *Expert Systems with Applications*, vol. 38, no. 11, pp. 14336–14345, 2011. doi:10.1016/j.eswa.2011.04.143.

[13] T. L. Saaty and L. G. Vargas, *Models, Methods, Concepts and Applications of the Analytic Hierarchy Process*, 2nd ed. New York, NY, USA: Springer, 2012.

[14] H. Sievert, A.-K. van den Ham, and A. Heinze, "The role of textbook quality in first graders' ability to solve quantitative comparisons: A multilevel analysis," *ZDM–Mathematics Education*, vol. 53, no. 6, pp. 1417–1431, 2021. doi:10.1007/s11858-021-01266-x.

[15] Department of Education (DepEd), *Most Essential Learning Competencies (MELCs): Mathematics*. Pasig City, Philippines: Department of Education, 2020.

[16] UNESCO, *Reimagining Our Futures Together: A New Social Contract for Education*. Paris, France: UNESCO Publishing, 2021.

[17] UNESCO, *Global Education Monitoring Report 2023: Technology in Education—A Tool on Whose Terms?* Paris, France: UNESCO Publishing, 2023.

[18] L. Fan, D. Wijayanti, D. Meng, K. Li, and M. Mailizar, "*The role of textbooks in the implementation of curriculum development:A comparative study through the lens of Chinese and Indonesian teachers' views*," ZDM–Mathematics Education, vol. 57, no. 5, pp. 935–949, 2025. doi:10.1007/s11858-025-01692-1.