A Tool to Assess the Quality of Self-learning Modules (SLMS) for the 'New Normal' in Education Using the Best-worst Method

Jammel Abraham S. Rico, Mindoro State University, Philippines
Leonel C. Mendoza, Mindoro State University, Philippines

The Asian Conference on Education 2021
Official Conference Proceedings

Abstract
In this paper, a tool to assess the quality of self-learning modules (SLMs) was developed using the Best Worst Method (BWM) by Rezaei (2015). Four major quality criteria namely Content *(weight = 0.603)*, Instruction *(weight = 160)*, Technicality *(weight = 0.097)*, and Ethical and Cultural Considerations *(weight = 0.140)* were established through the perspective of expert respondents and suggestions from literatures. Among these, Content is the most important. Nine sub-criteria for Content, Instruction, Technicality, and three for Ethical and Cultural Considerations were instituted, all of which were also analyzed for a best or most important sub-criterion. Complete coverage of the competencies *(weight = 0.200)* is the most important for Content; contextualization *(weight = 0.258)* is the best for Instruction; systematic and logical arrangement *(weight = 0.189)* is the most vital for Technicality; and indirect introduction of values and etiquette *(weight = 0.465)* is the most crucial for Ethical and Cultural Considerations. Real-life application of the tool proved that it can be used in comparing SLM quality. However, if the goal is not to compare, then the identified weights of each sub-criterion can assist educators in identifying which aspect can change or improve the quality of SLMs from each major criterion. This being said, results of this paper can be used to improve the over-all quality of SLMs being used in the implementation of the modular or blended learning approach. The assessment tool can also be applied to other instructional and learning materials such as textbooks, handouts, and presentations, among others.

Keywords: Assessment Tool, Self-learning Modules (SLM), New Normal, Education, Best-worst Method (BWM)

Introduction

With the COVID-19 pandemic affecting almost all essential sectors of society, education is devastated. The health crisis left educational institutions no choice but to close to prevent the further spread of the virus. As estimated, more than 1.5 billion students globally were affected by the closures of schools and universities (Obana, 2020). Despite this, the teaching and learning process continued for some, albeit virtually, a move favorable only to nations with adequate telecommunication infrastructures and easy access to computers and mobile technology. For nations that cannot support and sustain virtual distance learning, *blended distance learning* was implemented, as in the case for Philippine public schools. This approach utilizes available technologies such as mobile phones, computers, radio, television, and self-learning modules (SLMs).

Since Academic Year 2020-2021 opened, the shift to blended distance learning has been of much debate in the country, particularly regarding the quality of learning modules distributed to the students. Reports have emerged complaining about the numerous errors and discrepancies in the contents of SLMs and the educational videos curated by the Department of Education (DepEd) and aired through their partner TV network. Most of these errors are factual and computational or equation-related, as one article (Magsambol, 2020) cited. Other people had even reached out through social media, stating that classes should be halted. The system itself is not ready for the 'new normal' challenges in the educational landscape. In response, the Department of Education said that they would issue errata for SLMs, according to a report (Ronda, 2020).

Developing student learning modules and other instructional and learning materials is difficult (Campbell, 1999). Their relevance can influence instruction quality (Fuller, 1986), which directly affects students' learning and academic performance (Tety, 2016). Moreover, instructional resources are teachers' strategic elements in planning and delivering education because they explain concepts that teachers could not (Oni, 1992). This being said, better learning materials and services are needed to improve education quality, efficacy, and productivity (Likoko et al., 2013).

Their quality is challenged even further considering the vitality of instructional and learning resources like self-learning modules in the teaching-learning process. Education sits on an unfamiliar landscape due to the COVID-19 pandemic. In the blended learning approach implemented in the Philippines, SLMs are delivered to students, parents, or guardians personally by the teacher or through the assistance of the Local Government Units (LGUs) (Dangle & Sumaoang, 2020). Unlike in face-to-face classes where resources like textbooks are just supporting elements in teaching because most of the instruction process lies solely on the teacher, a large part of education in the COVID-19 era is given to the parents, the students themselves, and the self-learning modules (SLMs).

This means that independent study dominates today's educational context since students should learn on their own because face-to-face classes with a teacher is not possible yet. With little or no help from others, the learners progress on their own. Disadvantages of SLMs, as one paper (Dangle & Sumaoang, 2020) cited, is its implication of requiring students to exert greater self-discipline and motivation, increased preparation time and lack of rewards for teachers, and more significant resources needed for the production and distribution of SLMs.

Given the considerable importance of SLMs and considering the issues surrounding their quality during the implementation of the blended distance learning approach in the Philippines, this paper aims to propose a tool to assess SLM quality by objectively identifying quality metrics and their relative importance through the Best-Worst Method (BWM). The Best-Worst Method (BWM) is a multi-criteria decision analysis method developed by Rezaei (2015). The set of criteria that will be identified can be used as a standard model in assessing SLMs and other instructional and learning materials. The results of this paper can help educators identify the critical criteria or characteristics needed to produce a good quality self-learning module. By doing this, effective and productive instruction can be achieved even in the absence of face-to-face or in-person classes.

Objectives of the Study

This study aimed to develop a tool that can be used in assessing the quality of self-learning modules (SLMs) being distributed during the implementation of blended distance learning in the Philippines. Specifically, this paper sought to identify criteria that defines the quality of SLMs and determine their weights or degree of importance using the Best-Worst Method (BWM). Besides, this study also aimed to apply the tool that will be developed in assessing SLMs through a pilot assessment to prove that it can be used for the said cause.

Methodology

Research Design

The quality of self-learning modules' assessment can be framed as multi-criteria decision-making (MCDM) problem, which requires a multi-criteria decision analysis method. MCDM methods allow for criteria to be defined and be given weights. While there are multiple MCDM methods available, this paper used the Best-Worst Method (BWM) developed by Rezaei (2015). Compared to other existing methods, the Best-Worst Method requires less comparison data because it does not need a full pairwise comparison matrix (Salimi & Rezaei, 2018). Due to its structured pairwise comparison system, it produces more reliable results than the other methods. The BWM has been successfully used in various studies such as evaluation of scientific outputs (Salimi, 2017), assessment of risk (Torabi et al., 2016), measuring the efficiency of Ph.D. papers (Salimi & Rezaei, 2016), and management of water scarcity (Chitsaz and Azarnivand, 2016), to name a few. Its application in assessing instructional and learning materials specifically SLMs, on the other hand, is new.

Research Respondents

The first step in the Best-Worst Method (BWM) is determining a set of quality metrics through collecting perspectives from expert respondents and suggestions from literatures. To gather professional opinions regarding what criteria or characteristics define the quality of a sound self-learning module (SLM), 15 education experts from various institutions in the Province of Oriental Mindoro were purposively selected and given questionnaires. Similarly, expert respondents are also needed in conducting the second, third, and fourth steps of BWM. Given this, another set of 15 education experts were selected and as well given questionnaires. Details of the steps mentioned are discussed comprehensively in Data Analysis.

Data Collection

Two sets of questionnaires needed in BWM were formulated in this study. The first set of respondents was given the first questionnaire, including a personal data form and a single question inquiring on their perception of what sub-criteria or characteristics define an excellent learning module. Following Lemmer et. al. (2008), three significant criteria namely, content, instruction, and technicality, were pre-determined for the respondents to base their perceptions on. An 'others' category was also included; this is for the respondents to write the sub-criteria they think do not fall under the three pre-determined major criteria. On the other hand, the second questionnaire was given to the other set of expert respondents mentioned. Similar to the preceding questionnaire, it also includes a personal data form. However, this one contains highly-structured questions, which are needed to establish a Best-to-Others and Others-to-Worst vectors following the steps in BWM. Details on this step are highlighted in Data Analysis. Both questionnaires were distributed online through Google Forms.

Data Analysis

The steps of BWM are as follows:
Step 1. Determine a set of quality criteria. In this step, m $\{I_1, I_2, \ldots, I_m\}$ quality metrics or decision criteria are identified. These can be presented at different levels.

Step 2. Determine the best B (e.g. most important, most desirable) and the worst W (e.g. least essential, least desirable) quality criteria or sub-criteria based on the opinion of decision-makers (in this study, the decision-makers are selected education experts) and suggestions from existing literature.

Step 3. Determine the preference of the best criterion or sub-criterion over all the other criteria or sub-criteria through a 9-point scale (1: B is equally essential to j; 9: B is extremely more important than j). This results in a best-to-others vector:

$$A_B = (a_{B1}, a_{B2}, \ldots, a_{Bm})$$

where a_{Bj} indicates the preference of the criterion/sub-criterion B to over criteria/sub-criteria j and $a_{BB} = 1$.

Step 4. Determine the preference of all the criteria/sub-criteria over the worst criterion/sub-criterion through a 9-point scale. This results in an others-to-worst vector:

$$A_W = (a_{1W}, a_{2W}, \ldots, a_{nm})^T$$

where a_{jW} indicates the preference of criterion/sub-criterion j over the worst criterion/sub-criterion W.

Step 5. Find the optimal weights by minimizing the maximum absolute differences $\{|w_B - a_{Bj}w_j|, |w_j - a_{jW}W_w|\}$ for all j. Following Rezaei (2015), this can be formulated as:

$$\min \max_j \{|w_B - a_{Bj}w_j|, |w_j - a_{jW}W_w|\}$$

s.t.

$$\sum_j w_j = 1 \quad (1)$$

$w_j \geq 0$, for all j

To solve, it can be transferred to the following linear problem:

$$\min \xi^L$$

s.t.

$$|w_B - a_{Bj}w_j| \leq \xi^L, \text{ for all } j$$
$$|w_j - a_{jW}w_W| \leq \xi^L, \text{ for all } j \quad (2)$$
$$\sum_j w_j = 1$$

$w_j \geq 0$, for all j

The optimal weights $(w_1^*, w_2^*, \ldots, w_n^*)$ and ξ^L can be obtained by solving problem 2. ξ^L is the consistency index; the closer it is to 0, the more reliable the results are. In applying the developed tool to assess the quality of SLMs, an expert respondent rated a set of sample SLMs using a 9-point scale according to the different criteria and sub-criteria determined. Each score was normalized by multiplying them to the maximum score value. Results are then multiplied to the optimal weights obtained. The assessment scores are aggregated for analysis and interpretation.

Results and Discussion

As mentioned, the first step in BWM is the determination of criteria that would be given weights. There can be two sources in doing this step: (1) existing literature and (2) perspective of experts. In this study, both sources are used in identifying the set of criteria and sub-criteria that characterize the quality of self-learning modules. Through a literature review, the following decision criteria were identified:

Table 1. Criteria Suggestions from the Literature

References	Criteria Identified
Lemmer et al. (2008)	**Content** • All learning outcomes are included. • Contextualized to the learners' level. • Is rendered scientifically correct. • Different themes are presented separately. • Contents included are relevant. **Instruction** • Considers the background and environment of the learners in the activities. • Includes a variety of activities. • Assessment tasks are contextualized to the learners' level.

	• Tasks are accessible. **Technical** • Sufficient sketches are included. • Sketches are clear.
Devetak & Vogrinc (2013).	**General** • The structure is clear and transparent • Technical guidance is considered. • The content is consistent with the learning objectives/aims/goals. • The content is a learning- goals based. • Extents a coherent learning material in the framework of the specific educational program. • The inductive approach is used. • The content is correct. • The content is didactically adequate. • Suggestions for cross-curricular integration. **Textual** • Text is linguistically correct and appropriate. • Text contains motivational elements. • Text encourages active learning. • Text contains activities at different cognitive levels. **Pictorial** • Visuals are of high quality. • Visuals contain motivational elements. • Visuals stimulate recall. • Integration of visuals and text. • Different types of visuals. • Multi-presentational aspect of the visual. • Visuals in activities.

As reflected from Table 1, both the literature suggested almost the same set of characteristics defining an ideal instructional material, although both presented a different categorization. Devetak & Vogrinc (2013) used the term 'General' for characteristics comparable to what Lemmer et al. (2008) gave under the 'Content' category. For instance, both works emphasized the importance of correctness and accuracy of instructional and learning materials' contents. Moreover, both also believed that visuals are an essential characteristic of learning materials. As observed, Lemmer et al. (2008) underscored that sufficient precise sketches should be included, while Devetak & Vogrinc (2013) reiterated the integration of high quality visuals and texts.

Table 2. Profile of Expert Respondents

Questionnaire 1 *(Defining quality criteria for self-learning modules)*		Questionnaire 2 *(Determining the Best-to-Others and Others-to-Worst vectors)*	
Respondent No.	**Academic Rank/Position**	**Respondent No.**	**Academic Rank/Position**
1,3,5,11,12	Instructor I	8,10	Teacher I
4	Master Teacher I	15	Teacher II
2	Education Program Supervisor	6,8	SST I
9	Assistant Professor I	9	Principal II
10	Assistant Professor III	1	Master Teacher I
6,13	Assistant Professor IV	14	Master Teacher II
14	Associate Professor I	4	Education Program Supervisor
15	Associate Professor II	3,5,13	Instructor I
7,8	Associate Professor III	2	Assistant Professor III
		11,12	Associate Professor I

Since the criteria identified through the listed literatures shown in Table 1 are divided into categories, the same approach was used in gathering the perceptions of the selected expert respondents. The categories given by Lemmer et al. (2008) were adopted and considered as the primary criteria in this paper. The expert respondents were asked to suggest sub-criteria or characteristics of a sound self-learning module based on content, instruction, and technicality criteria. Also, they were allowed to suggest other sub-criteria that they think do not fall under the given main categories. These additional suggestions are then aggregated into a new primary criterion as shown in Table 4. The profile of expert respondents is shown in Table 2. The answers of the expert respondents are as follows:

Table 3. Perceptions of Expert Respondents

Criteria	**Sub-criteria**
Content	• Comprehensive • Relevant • Thorough • Concise • Compelling • Accurate • Well-organized and cohesive • Appropriate to the needs • Contents and outcomes are matched • Aligned with the course description • Topics and assessment is aligned with the intended learning outcomes • Adheres to the standards and requirements of the content/competencies • Covers the learning objectives of the course/subject

	• Clearly defines intended learning outcomes • Contains examples • Contains applications of theories and principles in real-life setting • Contains figures or pictures • Present simplified concepts • Explanations are brief • Facilitates self-paced learning • Discusses basic applications prior to complex situations • Contextualizes the course content as to the institution, sector, and the like • Fosters research by providing furthermore readings and references • Based on facts and credible sources • Not plagiarized
Instruction	• Self-paced • Caters to the demands of diversified learners • Differentiated and varied according to the level of learners • Easy to follow • Includes variety of interactive activities/exercises/hands-on • Includes relevant tasks • Includes different activities that will enhance cognitive learning • Includes activities that are eco-friendly and not costly • Includes activities and projects that are problem-based • Applies HOTS in questions • Integrates activities which encompass all multiple intelligence • Creative in facilitating the learning process • Contains clear, attainable, and output-oriented outcomes • Competency-focused • Engaging • Considers the multiple intelligences of students • Outcome-based • Contains helpful references • Enhances dynamic and systematic learning through exploration and related researches • Incorporates the use of communication and information technologies • Clear instructions • Encourages reflective practice and self-evaluation
Technicality	• Grammatically-correct • Logically-arranged • Not plagiarized • Has good lay-out • Shall be IPR-passed • Systematized introduction of topics • Has uniform formatting • Has readable font style • Scholarly-constructed • Reviewed by IMEC • Free from a number of jargons

	•	Uses consistent terminologies or concepts
	•	Uses simple sentences
	•	Uses clear pictures
	•	No spelling errors
	•	Cites sources properly
Others	•	Introduces good values and good etiquette indirectly
	•	Observes cultural and ethical considerations

As presented in Table 3, some responses resonated with the suggestions from the literature. For example, both agreed that content should be consistent or aligned with the learning objectives/aims/goals. Also, the expert respondents recognized the importance of having correct grammar and spelling, an inductive approach to presenting the contents, and the integration of varied and high-quality visual elements, to name a few. These responses from experts were compared and fused with the suggestions from the literature. Some answers were combined, while others were omitted because they were redundant. Other items were also transferred to other main criteria. By doing this, the final set of criteria and sub-criteria that defines the qualities of a sound learning module were able to be identified. These metrics can now serve as an initial basis for educators in formulating SLMs and other instructional and learning materials. Another significant criterion, which is the Ethical and Cultural Considerations, as seen in Table 4, was set. This happens because expert respondents' specific characteristics as not fitted to the other three major criteria (in Others, Table 3) imply the importance of giving considerations for ethics and cultural diversity. The summarized and final set of criteria and sub-criteria are as follows:

Table 4. Final Set of Criteria and Sub-criteria

Criteria	**Sub-criteria**
Content	(C1) Learning competencies are covered (C2) Texts and visuals are accurate and error-free (C3) Contents and outcomes are matched (C4) Aligned with the course description (C5) Topics and assessment are aligned with the intended learning outcomes (C6) Covers the learning objective of the course/subject (C7) Defines intended learning outcomes (C8) Contains theories and principles in real life setting (C9) Comprehensive and based on facts and credible sources
Instruction	(I1) Appropriate and contextualized according to the needs (i.e. learning styles, multiple intelligences, etc.) of the learners/students (I2) Includes variety of relevant and interactive written and performance tasks (I3) Encourages the use of ICT (I4) Provides development of cognitive, affective, and psychomotor domains of students (I5) Discusses basic applications prior to complex situations (I6) Includes research outputs as supplementary materials in instruction (I7) Uses problem-based activities/projects and frames questions that encourage higher order thinking skills (I8) Encourages reflective practice and self-evaluation (I9) Self-paced
Technicality	(T1) Has correct grammar and spelling

	(T2) Logically and systematically-arranged (T3) Not plagiarized and sources are cited properly (T4) Has good lay-out (T5) Has uniform formatting (T6) Has readable font style (T7) Uses clear pictures (T8) Uses simple but scholarly-constructed sentences (T9) Uses consistent terminologies or concepts
Ethical and Cultural Considerations	(EC1) Introduces good values and good etiquette indirectly (EC2) Observes ethical considerations (EC3) Observes cultural considerations

Now that the final decision criteria are identified, the optimal weights were able to be solved. This is done in order to find the relative importance of each criterion so educators can know which characteristic or area of SLMs they should prioritize and give attention to. However, it does not imply that the least important one would be neglected and given the least attention; these weights can be a point of comparison for educators in identifying which criteria affect an SLM's quality the most. In doing this, another 15 selected expert respondents were asked to choose their preferred best and worst criterion. The profile of these respondents is shown in Table 2. The expert respondents were also instructed to compare their selected best criterion to the other criteria in a scale of 1 to 9. One signifies that the best criterion is equally crucial to the other criteria. At the same time, 9 implies that it is extremely more important than the others. This comparison resulted in a Best-to-Others vector.

Similarly, the other criteria are compared to the selected worst criterion using the same scale, resulting in an Others-to-Worst vector. The resulting weights are shown below in Table 5. Note that these weights are the average of all the weights identified from each respondent.

Table 5. Relative Weights of Criteria And Sub-criteria

Criteria	**Criteria weights**	**Criteria rank**	**Sub-criteria**	**Local weights of sub-criteria**	**Global weights of sub-criteria[a]**
Content	0.603	1	(C1) Learning competencies are covered	0.200	0.121
			(C2) Texts and visuals are accurate and error-free	0.066	0.040
			(C3) Contents and outcomes are matched	0.140	0.084
			(C4) Aligned with the course description	0.084	0.051
			(C5) Topics and assessment are aligned with the intended learning outcomes	0.111	0.067
			(C6) Covers the learning objective of the course/subject	0.080	0.048
			(C7) Defines intended learning outcomes	0.071	0.043

			(C8) Contains theories and principles in real life setting	0.155	0.093
			(C9) Comprehensive and based on facts and credible sources	0.092	0.055
Instruction	0.160	2	(I1) Appropriate and contextualized according to the needs (i.e. learning styles, multiple intelligences, etc.) of the learners/students	0.258	0.041
			(I2) Includes variety of relevant and interactive written and performance tasks	0.084	0.013
			(I3) Encourages the use of ICT	0.061	0.010
			(I4) Provides development of cognitive, affective, and psychomotor domains of students	0.099	0.016
			(I5) Discusses basic applications prior to complex situations	0.089	0.014
			(I6) Includes research outputs as supplementary materials in instruction	0.075	0.012
			(I7) Uses problem-based activities/projects and frames questions that encourage higher order thinking skills	0.096	0.015
			(I8) Encourages reflective practice and self-evaluation	0.125	0.020
			(I9) Self-paced	0.112	0.018
Technicality	0.097	4	(T1) Has correct grammar and spelling	0.171	0.017
			(T2) Logically and systematically-arranged	0.189	0.018
			(T3) Not plagiarized and sources are cited properly	0.132	0.013
			(T4) Has good lay-out	0.070	0.007
			(T5) Has uniform formatting	0.076	0.007
			(T6) Has readable font style	0.086	0.008

			(T7) Uses clear pictures	0.083	0.008
			(T8) Uses simple but scholarly-constructed sentences	0.116	0.011
			(T9) Uses consistent terminologies or concepts	0.076	0.007
Ethical and Cultural Considerations	0.140	3	(EC1) Introduces good values and good etiquette indirectly	0.465	0.065
			(EC2) Observes ethical considerations	0.392	0.055
			(EC3) Observes cultural considerations	0.143	0.020

[a]The global weights indicated are obtained by multiplying the local weights of the sub-criteria to the weights of the main criteria where they belong.

As reflected from Table 5, Column 2, Content (weight = 0.603) is the best or most important criterion out of the four major criteria. This is followed by Instruction (weight = 0.160), Ethical and Cultural Considerations (weight = 0.140), and Technicality (weight = 0.097). The consistency ratios (ξ^L) range from 0.153 to 0.279, which implies high reliability of comparison among the major criteria. Interestingly, the placement of Content and Instruction as the first and second most important criteria respectively resonated with proposed framework in Tarr et al (2006). The said paper posits that content emphasis and instructional focus should be one of the three important dimensions that should be considered in reviewing instructional resources.

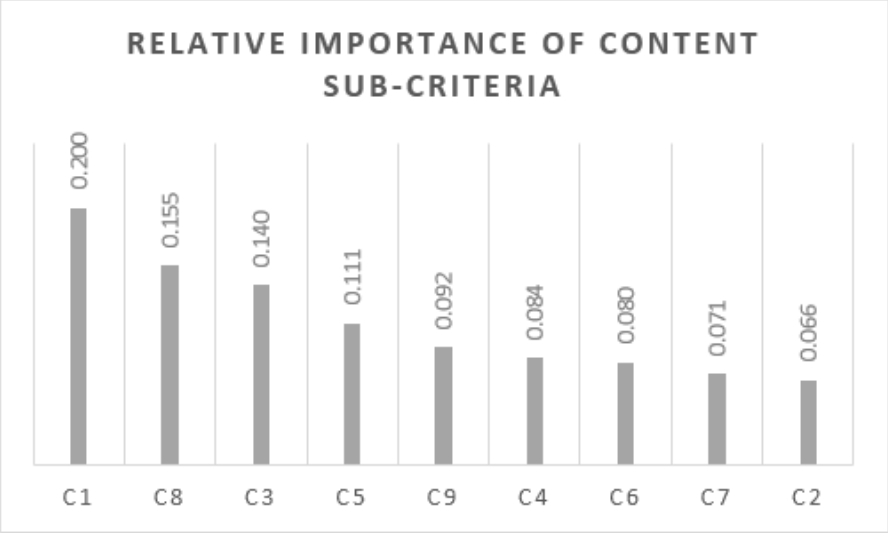

Figure 1. Relative Weights of the Sub-Criteria of Content

In Content, C1 (weight = 0.121) is selected as the best or most crucial sub-criterion, as shown in Figure 1. This sub-criterion pertains to the coverage of learning competencies. Its placement as the essential sub-criterion of Content implies that the education expert respondents perceived that the complete inclusion of learning competencies prescribed in the

curriculum should always be ensured. Also, C8, which emphasizes the addition to SLMs of theories and principles in a real-life setting, ranked second. This mirrored the assumption of several papers that an essential aspect of instructional and learning materials is the suitability of its contents to be used in everyday applications (Dreckmeyr et al., 1994; Leite, 1999; Hubisz, 2003).

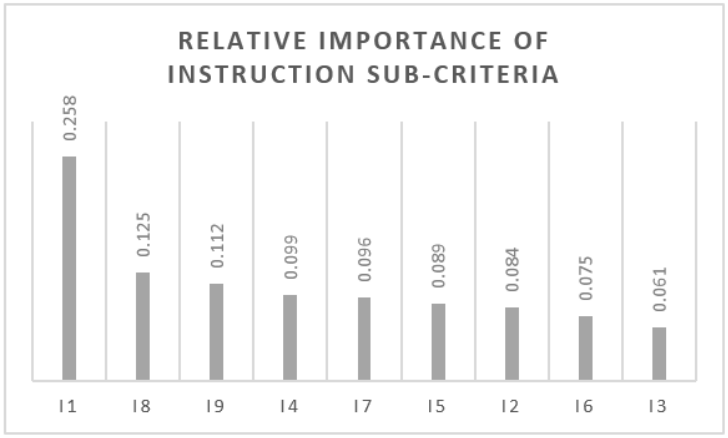

Figure 2. Relative Weights of the Sub-criteria of Instruction

As mentioned, Instruction (weight = 0.160) is ranked as the second-best major criteria. I1 (weight = 0.041), which focuses on the contextualization according to learners' varied needs is the most important sub-criterion of Instruction, as reflected from Figure 1. Several papers have agreed on the vitality of instruction in the production of learning resources, specifically in contextualizing its contents and instructional strategies to learner's varied needs. Contextualization constructs and transforms a more extensive environment for students (Haris & Putri, 2011; Weinberg, Besile, & Albright, 2011). When content and instruction are contextualized, materials, experiences, and situations that are relevant and meaningful to students are considered (Madrazo & Dio, 2020). However, contextualization requires time given the unavailability of local materials and pedagogical difficulty. Also, the fact that the learners' needs are various means that not all topics may be applicable (Madrazo & Dio, 2020). These disadvantages, given that BWM showed that it is a crucial sub-criterion, imply that educators shall give sufficient attention to the contextualization of Content and the strategies they will incorporate in their SLMs.

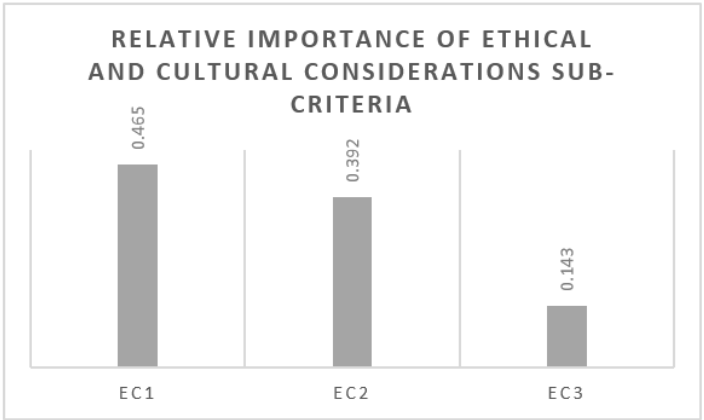

Figure 3. Relative Weights of the Sub-criteria of Ethical and Cultural Considerations

Ethical and Cultural Considerations (weight = 0.140) ranked as the third most important major criteria. EC1 (weight = 0.065), which emphasizes the introduction of good etiquette and values is the most important sub-criterion of Ethical and Cultural Considerations, as shown in Figure 3. Education, in general, is the best way to teach people about values (Sari, 2013). A paper (Veugelers & Vedder, 2003) posits on the importance of integrating Ethics in classrooms, emphasizing that the set of values embedded in the curriculum must be included in teachers' pedagogical paractice. As argued by several papers (Goodman et al., 1992; Edwards et al., 1994), this exercise is a way to prepare students to function in a democratic society. To satisfy this sub-criteria, instructional and learning materials, including SLMs, should be based on living values and grounded on knowing, desiring, loving, and acting the good (Komalasari & Sapudin, 2017). Moreover, the materials must be contextual, bridging the values with their real-life application.

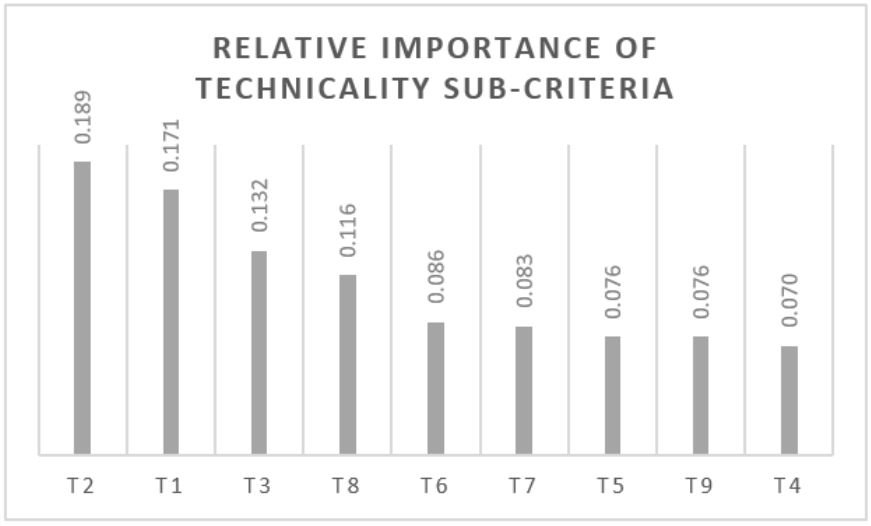

Figure 4. Relative Weights of the Sub-criteria of Technicality

Ranked last is Technicality (weight = 0.097). T2 (weight = 0.018), which deals with the logical and systematic arrangement of contents in SLMs is the most important sub-criterion of Instruction, as reflected in Figure 4. A paper (Dreckmeyr et al., 1994) emphasized that technical aspects such as quality of illustration, sketches, and graphs should be considered in learning materials like textbooks; the same applies for SLMs. Given this, teachers should ensure that there are no blurry visual elements when they produce SLMs. Defective illustrations sometimes result from poor photocopying quality; thus, they should be given attention during production.

Real-life Application

After the quality criteria are identified and given weights, the developed tool can now be applied to assess student learning modules. In this paper, the first four learning modules in Science given to the Grade 6 students of Mangangan II Elementary School in Mangangan 2, Baco, Oriental Mindoro were used in the pilot assessment. The resident Master Teacher II of the said school was the expert respondent asked to rate the SLMs. The SLMs were rated on a scale of 1-9 according to the 30 quality criteria identified. The scores are normalized and finally multiplied to the respective global weights of each criterion. Results are shown below in Table 6. The score of the best performing SLMs for every criterion is highlighted.

Table 6. Comparison of the Quality of SLMs

Quality criteria	SLM 1 (Science 6, Week 1 – Quarter 1)	SLM 2 (Science 6, Week 2 – Quarter 1)	SLM 3 (Science 6, Week 3 – Quarter 1)	SLM 4 (Science 6, Week 4 – Quarter 1)
C1	**0.121**	**0.121**	**0.121**	**0.121**
C2	**0.040**	0.036	0.036	**0.040**
C3	0.075	**0.084**	0.075	0.065
C4	**0.051**	**0.051**	0.040	0.045
C5	0.060	**0.067**	0.052	0.052
C6	0.048	0.043	0.052	**0.067**
C7	**0.043**	**0.043**	0.038	**0.043**
C8	0.083	0.083	0.072	**0.093**
C9	**0.055**	**0.055**	0.049	**0.055**
I1	0.032	**0.041**	**0.041**	**0.041**
I2	0.012	**0.013**	0.012	0.012
I3	**0.010**	0.008	0.008	**0.010**
I4	0.012	0.012	0.012	**0.016**
I5	**0.012**	**0.012**	**0.012**	**0.012**
I6	**0.012**	**0.012**	**0.012**	**0.012**
I7	**0.015**	0.013	**0.015**	**0.015**
I8	**0.020**	0.018	0.018	0.018
I9	**0.018**	**0.018**	0.014	**0.018**
T1	**0.017**	**0.017**	0.015	**0.017**
T2	**0.016**	**0.016**	0.014	**0.016**
T3	0.012	**0.013**	**0.013**	0.012
T4	0.006	**0.007**	**0.007**	0.005
T5	0.005	0.005	0.006	**0.007**
T6	**0.007**	**0.007**	0.006	**0.007**
T7	**0.008**	0.007	0.006	0.007
T8	**0.010**	**0.010**	0.009	**0.010**
T9	**0.007**	0.005	**0.007**	0.006
EC1	**0.065**	0.058	**0.065**	**0.065**
EC2	0.049	**0.055**	**0.055**	**0.055**
EC3	**0.020**	0.018	0.020	0.018
Aggregated Score	0.031	**0.032**	0.030	**0.032**

As reflected from Table 6, SLMs 2, and 4 both obtained equal aggregated scores of 0.032, while SLM 1 obtained 0.031. In contrast, SLM 3 obtained 0.030, which is the lowest. These results imply that there is almost no difference in the quality of all self-learning modules used in the pilot assessment as perceived by the expert respondent. Since this is the case, the comparison of individual scores can give perspective on the standing of each SLM used according to every criterion identified. Individual scores can give insights on which quality criterion an SLM needs improvement when compared to other SLMs.

However, if the objective is not to compare SLMs, knowing each quality criterion's vitality can help educators formulate and produce quality and practical self-learning modules based on their objective. For instance, if teachers want to improve their SLMs in terms of instruction, they have to focus on contextualizing the Content according to learners' varied

needs, since the results in Table 5 showed that the criterion focusing on contextualization (T1) is the most important for instruction. The same applies if educators want to shift the focus of their objectives during the formulation and production of SLMs. This suggests that the weights identified in the earlier part of this paper should be taken into account when formulating an SLM. Each value would affect the over-all quality; the bigger the weight, the higher it affects the quality. In general, regardless of knowing the advantage of SLMs to other SLMs, based on each quality sub-criterion's weights, teachers can identify which aspect can change or improve the quality of SLMs from each significant criterion. This being said, the results of this paper can help improve the over-all quality of self-learning modules.

Conclusion

This paper established a tool to assess self-learning modules' quality through the Best Worst Method (BWM). Using expert respondents' perspectives and the suggestions from existing studies and literature, four primary quality criteria, namely Content, Instruction, Technicality, and Ethical and Cultural Considerations were identified and given weights; among these, Content is the most important. Each primary criterion has its sub-criteria with individual weights, establishing a total of 30 quality sub-criteria. Application of the tool proved that it can be used in comparing the quality of SLMs. Moreover, suppose comparison is not the objective. In that case, each quality metric's identified weights can be used in recognizing which aspect can improve the quality of SLMs since the weights signify the degree of importance of each metric. This paves the way for the formulation and production of effective and productive self-learning modules. The developed framework is also holistic; thus, it can also be applied to other instructional and learning materials like textbooks.

Recommendations

To increase the reliability (ξ^L) of the comparison of the criteria (that is, during the establishment of Best-to-Others and Others-to-Worst vectors) by the expert respondents, answering the questionnaire should be done in-person to ensure that the objective of the method and the nature of each quality metric are clearly explained.

Acknowledgements

The author is grateful for the time and effort put in by the Bachelor of Secondary Education (Science) students at Mindoro State University-Calapan City Campus who participated in this study. Sincere gratitude is also extended to Mr. Leonel Mendoza, the University's Coordinator for Research and Development, for contributing his expertise to the completion of this study. Finally, thanks are extended to the author's family and friends for their invaluable support and motivation.

References

Campbell, Clifton P. (1999). Instructional materials: their preparation and evaluation. Journal of European Industrial Training, 23(2), 57–107. doi:10.1108/03090599910257515

Chitsaz, N., & Azarnivand, A. (2017). Water scarcity management in arid regions based on an extended multiple criteria technique. *Water Resources Management*, *31*(1), 233-250.

Dangle, Y. R. P., & Sumaoang, J. D. (2020, November). *The Implementation of Modular Distance Learning in the Philippine Secondary Public Schools*. 3rd International Conference on Advanced Research in Teaching and Education, Dublin, Republic of Ireland. https://www.dpublication.com/wp-content/uploads/2020/11/27-427.pdf

Devetak, I., & Vogrinc, J. (2013). The criteria for evaluating the quality of the science textbooks. In *Critical analysis of science textbooks* (pp. 3-15). Springer, Dordrecht.

Dreckmeyr, M., Maarschalk, J., & McFarlane, L. R. (1994). *Successful physical science teaching: A guide for teachers and student teachers*. Kagiso Tertiary.

Edwards, L., Munn, P., & Fogelman, K. R. (Eds.). (1994). *Education for Democratic Citizenship in Europe: New Challenges for Secondary Education: Report of the Seventh European Conference of Directors of Educational Research Institutions Held in Nitra (Slovakia) 27-30 October 1992*. Swets & Zeitlinger, Academic Pub. Division.

Fuller, B. (1986).” Raising school quality in developing countries. What investment boosts learning?” The World Bank discussion paper, Education and training series. New York: Praeger Publishers

Goodman, J., Kuzmic, J., & Wu, X. (1992). *Elementary schooling for critical democracy*. Suny Press.

Haris, D., & Ilma, R. (2011). The Role of Context in Third Graders' Learning of Area Measurement. *Indonesian Mathematical Society Journal on Mathematics Education*, *2*(1), 55-66.

Hubisz, J. (2003). Middle-school texts don't make the grade. *Physics today*, *56*(5), 50-54.

Komalasari, K., & Saripudin, D. (2017). A model of living values education-based civic education textbooks in Indonesia. *The New Educational Review*, *47*(1), 139-150.

Leite, L. (1999). Heat and temperature: An analysis of how these concepts are dealt with in textbooks. *European journal of teacher education*, *22*(1), 75-88.

Lemmer, M., Edwars, J. A., & Rapule, S. (2008). Educators\'selection and evaluation of natural sciences textbooks. *South African Journal of Education*, *28*(2), 175-188.

Likoko, S., Mutsotso, S., & Nasongo, J. (2013). The adequacy of instructional materials and physical facilities and their effects on quality of teacher preparation in emerging private primary teacher training colleges in Bungoma County, Kenya.

Madrazo, A. L., & Dio, R. V. (2020). Contextualized learning modules in bridging students'learning gaps in calculus with analytic geometry through independent learning. *Journal on Mathematics Education, 11*(3), 457-476.

Magsambol, B. (2020, October 23). 30 errors found in DepEd's learning modules. *Rappler*. https://www.rappler.com/nation/errors-identified-deped-learning-modules-distance-learning

Obana, J. (2020). What will schools look like under the „new normal"? The Manila Times. P&A

Grant Thornton. May 13, 2020 https://www.manilatimes.net/2020/05/13/business/columnists-business/what-will-schools-look-likeunder-the-new-normal/724556/

Oni, J.O. (1992). Resource and Resource Utilization as Correlates of School Academic Performance. Unpublished Ph.D Thesis, University of Ibadan, Ibadan, Nigeria.

Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega*, *53*, 49-57.

Ronda, R. A. (2020, October 12). DepEd to issue errata for learning modules. *Philstar.Com*. https://www.philstar.com/headlines/2020/10/13/2049195/deped-issue-errata-learning-modules

Salimi, N., & Rezaei, J. (2016). Measuring efficiency of university-industry Ph. D. projects using best worst method. *Scientometrics*, *109*(3), 1911-1938.

Salimi, N. (2017). Quality assessment of scientific outputs using the BWM. *Scientometrics*, *112*(1), 195-213.

Salimi, N., & Rezaei, J. (2018). Evaluating firms' R&D performance using best worst method. *Evaluation and program planning*, *66*, 147-155.

Sari, N. (2013). The importance of teaching moral values to the students. *Journal of English and Education*, *1*(1), 154-162.

Tarr, J. E., Barbara, J., Reys, D., Baker, D., & Billstein, R. (2006). Selecting high-quality science textbooks. *Columbia, Texas: University of Missouri*.

Tety, J. L. (2016). Role of Instructional Materials in Academic Performance in Community Secondary Schools in Rombo District" (Doctoral dissertation, The Open University of Tanzania).

Torabi, S. A., Giahi, R., & Sahebjamnia, N. (2016). An enhanced risk assessment framework for business continuity management systems. *Safety science*, *89*, 201-218.

Veugelers, W., & Vedder, P. (2003). Values in teaching. *Teachers and Teaching*, *9*(4), 377-389.

Weinberg, A. E., Basile, C. G., & Albright, L. (2011). The effect of an experiential learning program on middle school students' motivation toward mathematics and science. *RMLE Online*, *35*(3), 1-12.

Contact email: leonelmendoza49@gmail.com
mcc.research02@gmail.com