Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 4 (2), 10-16, 2022

Acceptability of Paper Folding-Based Instructional Material in Geometry

Sharon F. Galicha and Metelyn S. Lazaro

ABSTRACT

The study focused on the acceptability of a developed supplementary learning material (SLM) in geometry in terms of adequacy, clarity, contents, objectives, suitability and usefulness. It was subjected to the scrutiny of competent DepEd Mathematics teachers and professors in mathematics at two universities, Romblon State University and De La Salle University. The study concludes that the developed SLM titled "Paper Folding in Geometry" is highly acceptable in terms of adequacy, clarity, content, objectives, suitability, and usefulness. It was also revealed that there is no significant difference between the level of acceptability between the teacher-evaluators from CHED and those from DepED. The development of the SLM is on its initial stage yet as it has to be pilot tested with grade six elementary pupils as participants.

Keywords: *supplementary learning material, paper folding, acceptability, content validity*

INTRODUCTION

Geometry is an area in mathematics that has the widest and most visible application in real life. Various shapes and sizes can be observed in this sphere's rocks, plants, sea creatures, birds, animals, and heavenly body formations. An in-depth knowledge of geometric figures, their properties, and measurements is essential in understanding other fields like engineering, architecture, science and arts, and even technology education. The study of geometry trains learners to think, analyze, critique, and argue. In short in geometry, learners are trained to reason logically. It teaches them to be more coherent in expressing their ideas, be sequentially and systematically organized in thoughts, and become explorative and creative thus able to meet the demands of the rapid changes in science and technology in a world that struggles to win a fight against the Covid-19 pandemic. In a situation like this, the Commission on Higher Education (CHED) together with the Department of Education (DepEd) work together to switch from face-to-face teaching to distance learning with the use of modular and e-learning approaches. The difficulty now lies on how to enable students to develop logical or geometric reasoning.

✉ sgalicha6@gmail.com

College of Education, Romblon State University, Odiongan, Romblon

Received 8 April 2022; Revised 27 September 2022; Accepted 19 October 2022

While geometric concepts are introduced in the primary grades, it is in junior high school that students are taught the basics of geometric reasoning. In grades 9 and 10, they are introduced to the use of deductive reasoning in proving theorems. It is certain that the task to teach geometric reasoning to learners during this pandemic is challenging. In this regard, this research focused on the acceptability of a supplementary learning material (SLM) in geometry which uses paper folding as a manipulative. This learning material shows the step-by-step process of folding lines, angles, triangles, circles, and selected polygons and their parts allowing the learner to be self-directed. In this rapidly changing society, individuals must learn how to direct themselves in acquiring information and knowledge to be able to survive and compete with others (Torrefranca, 2017).

Several studies had shown that visual aids and manipulatives are very useful in understanding mathematics and in the retention of mathematical concepts. Spatial abilities are enhanced through the infusion of origami in mathematics lessons as revealed in the research done by Cornelius and Tubis (2003). In the study conducted by Galicha and Lazaro (2019) they concluded that infusion of paper folding in the teaching of Geometry is an effective method of enhancing geometric reasoning skills.

During the pandemic, young learners can benefit from manipulatives or hands-on activities at home especially with their parents' supervision. Together, parents and children can have fun exploring and understanding math concepts. This family activity will help enhance children's math skills as well as develop

positive math attitudes. Learners' math anxiety will be lessened as they will enjoy working on their math activities with the use of manipulatives like paper folding. There is no doubt that most parents find their children's math home works very challenging hence, a supplementary learning material which introduces the use of math manipulatives is an advantage. Eventually, algebra or calculus problems will involve geometric figures, so it is important to make sure children are properly prepared by using quality geometry resources both in the classroom and at home. This study is corollary to previous research with title "Contextualization of Geometric Concepts through Paper Folding: Basis for Development of Instructional Materials in Geometry" which was also conducted by these researchers. Hence, the design of the developed supplementary learning material is focused on the enhancement of the geometric reasoning skills of the learners.

Supplementary Learning Material (SLM) Development

With the rise of COVID-19 infection students have to be home-schooled and parents have no other alternative but to assist their children in understanding the contents of their learning module. Thus, there is an undeniable need for supplementary learning materials. Kapur (2019) asserted that in educational institutions, the development of teaching-learning materials is regarded as one of the major aspects that would promote student learning and help in the achievement of academic goals and objectives. Books are effective methods of imparting basic knowledge to students in terms of concepts. It is obvious that there's a lack of these materials as indicated in Llego's (2018) article, 'A Call for Submission for Evaluation of Supplementary Learning Resources (SLR) for Public School Libraries', where he stated that these materials have to be made available and accessible to teachers and learners in order to develop positive reading and study habits and develop the ability to use these resources efficiently and effectively as tools of learning and teaching. He added that SLRs found in libraries must contain information and knowledge that will lead towards the achievement of curricular goals.

Engaging students to do their learning tasks poses a challenge to teachers especially in their absence. Only a few students are self-driven and therefore learning materials must contain that element which will activate the student's natural urge to learn. As cited by Dewi and Haharap (2016), Wijaya and Rohmadi (2009) stated that the success of a teaching-learning process is not solely determined by a reliable teacher, good input, and teaching facilities such as school buildings, teaching tools, or libraries but also by the selection of appropriate and quality teaching materials. Salcedo (2016) points out that teachers should be encouraged to develop instructional materials like a module, particularly on subjects/topics where most students encounter difficulty. Instructional materials play an important role in the foundation of learning in the classroom according to Pangesti (2012) as cited also by Dewi and Haharap (2016). To address this need, the design and development of an instructional material in mathematics should then be called forth.

After the development of the SLM, its acceptability among the teachers and the learners must be ascertained. In his paper, Molano (2020) concluded that his proposed innovative learning material in statistics and probability is found to be very acceptable in terms of its objectives, contents and clarity. Results of the study conducted by Rogayan and Dollete (2019) revealed that their developed workbook in physical science evaluated based on criteria that include adequacy, coherence, appropriateness, and usefulness is very much acceptable. Espinar and Ballado (2016) argued that since learning materials significantly increase students' achievements then validating and identifying the level of acceptability of a developed worktext is just fitting. This will allow the students to learn the materials in the easier way because the lessons are presented in the language suited to the students' level.

In their study on the development and validation of project-based module for biology, Cruz and Rivera (2022) stated that they selected validators of their study those teachers that have specialization in biology, and seasoned teachers that are teaching biology for five years or more. They involved those that are well-versed in curriculum design and instruction, as well as those that are in a similar area in the teaching field that are considered as experts and consultants in the said endeavor.

As to studies regarding variations in the perception on the level of acceptability of a learning material by the evaluators from different categories, Auditor and Naval (2014) disclosed that they found no statistically significant difference between the evaluation of the students, peers, and experts on their physics modules' acceptability.

This study evaluated and determined the level of acceptability of a developed learning material in geometry. The researchers also determined the significant difference between the evaluation of teachers teaching mathematics in college (CHED) and those teaching the subject in high school (DepED).

METHODOLOGY

Method

This study used developmental research that employed the ADDIE model. It is an instructional

design, which serves as guide in creating effective educational courses and materials (Instructional Design, 2015). The model consists of five (5) phases, namely: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. This present study however, temporarily excluded the fifth phase (evaluation) in the research process as it requires student participation which is difficult because of the existing pandemic and the restricting policies for the young people. Hence, the current research only went through the four (4) phases illustrated in Figure 1.

In the implementation phase, the developed SLM was assessed based on six criteria: adequacy, clarity, content, objectives, suitability, and usefulness. The mean and standard deviation of each criterion indicator were computed and interpreted. To determine the significant difference between the evaluation of teachers from DepED and those from CHED, the *t*-test for independent samples was utilized.

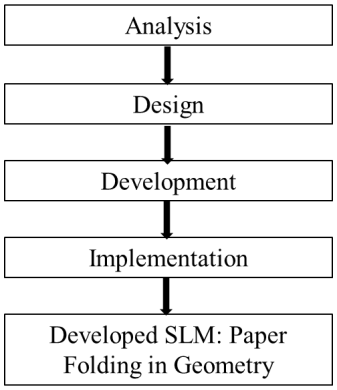

Figure 1. The Development Chart of the SLM

Phase 1: Analysis

This developed SLM in Geometry is based on a previously conducted research that involved paper folding to contextualize geometric concepts. Hence, the analysis phase of this current research was already carried out during the conduct of the previous study. It utilized the quasi-experimental pretest/posttest design to determine whether the use of paper folding is effective in enhancing the geometric reasoning skills of students. The results of the analysis phase served as basis for the choice of topics and exercises that were included in the SLM.

Phase 2: Design

It is in this stage when the researchers decided on the coverage of the SLM. It is divided into four chapters: Chapter 1 covers points, lines and planes; Chapter 2 focuses on angles; Chapter 3 deals with triangles and quadrilaterals; and Chapter 4 includes circles and some polygons. Every chapter contains an introductory statement, a learning outcome, learning objectives, content discussion and paper folding exercises.

Phase 3: Development

This is the phase in which the researchers started writing the entire material. The contents were written with grade six students as target audience in consonance with the fact that the researchers deemed it necessary for the learners' reasoning ability to be developed at an early age.

Phase 4: Implementation

The evaluators of the SLM were three DepEd Math teachers from three districts of Romblon and three Math professors from Romblon State University and the De La Salle University, Manila. They were selected using non-probability purposive sampling technique. Two of these evaluators are authors of published books in algebra and calculus and thus can be considered as experts in instructional material development. Another evaluator is the main proponent of a developmental research that introduced the use of a modified set of cards to be used as teaching tools in probability. The rest of the evaluators were selected by the researchers based on their mathematics performance when they were undergraduate and graduate students. Their number of years of experience as a DepEd math teacher which is five (5) years or more was also considered. They evaluated the SLM's content validity based on adequacy, clarity, content, objectives, suitability, and usefulness using an evaluation tool for instructional materials adopted with some modifications from the College of Education (CED) of the university. The instrument was already validated by the CED committee of educators who each represent the different programs of the College.

RESULTS AND DISCUSSION

Content Validity of the Developed SLM

Table 1 presents the results of evaluation of the SLM by math experts. As seen from the table, the SLM obtained a very good rating as to adequacy (*M = 4.74; SD =0.32*). The evaluators indicated that they strongly agree with each of the indicators, implying that the SLM is acceptable in quality. One evaluator's comment was that the activities can be tried as diagnostic test for students entering college and those intending to take architecture or engineering courses. The researchers took note of one evaluator's suggestion that learning tasks should not just be limited to paper folding activities but should also include real-life applications.

The SLM also got a very good rating in terms of clarity (*M = 4.71; SD = 0.32*). The evaluators strongly agreed with all the indicators but for one: the provision

Table 1. Expert's Validation of the SLM in Geometry

Criteria	Mean ± SD	Verbal Description
Adequacy		
1. Tasks and other activities can tap the creativeness of the learners.	4.86±0.18	SA
2. Tasks and other activities can tap the resourcefulness of the learners.	4.86±0.18	SA
3. Manipulative activities are carefully designed to suit the level of the learners.	4.86±0.18	SA
4. Activities are adequate to measure learner's performance.	4.87±0.60	SA
5. Activities include a miniature of the outside world which are evident in local setting.	4.87±0.60	SA
Grand Mean	4.74±0.32	SA
Clarity		
1. Thought- provoking questions are stated in a way that can easily be understood by the learner.	4.43±0.69	A
2. Activities are well-designed to develop creativity among the learners.	4.86±0.18	SA
3. Activities are well-planned for greater participation among learners.	4.86±0.18	SA
4. Directions are clearly stated resulting to better perception of the varied activities presented.	4.71±0.51	SA
5. Graphics and illustrations used support concepts and thought processes.	4.71±0.51	SA
Grand Mean	4.71±0.32	SA
Content		
1. It reveals the learners' intellectual abilities.	4.71±0.38	SA
2. It supports the instructional objectives.	4.86±0.18	SA
3. It enhances the learners' critical thinking skills.	4.86±0.18	SA
4. It develops the learners' ability to understand the topic of discussion.	4.86±0.18	SA
5. It encourages independent learning.	4.86±0.18	SA
Grand Mean	4.83±0.22	SA
Objectives		
1. They are specific/comprehensive.	4.86±0.49	SA
2. They are stated in behavioral terms.	5.00±0.00	SA
3. They are sufficient to satisfy learner's needs.	4.86±0.18	SA
4. The projected learning activities are achievable.	5.00±0.00	SA
5. They are meant to measure the learning ability of the learner.	4.86±0.18	SA
Grand Mean	4.91±0.12	SA
Suitability		
1. Activities are adapted to the level of the learners.	5.00±0.00	SA
2. Activities are diverse with respect to level of difficulty.	4.43±0.69	A
3. Lessons are presented in the correct sequence.	4.46±0.18	A
4. Careful planning, selecting and designing of activities that develop critical thinking skills and creativity among learners are evident.	4.86±0.18	SA
5. Activities are relevant to the descriptions and specification of the course objectives.	5.00±0.00	SA
Grand Mean	4.83±0.18	SA
Usefulness		
The Supplementary Learning Material		
1. serves as motivation to the learners.	4.86±0.18	SA
2. promotes independent learning.	4.86±0.18	SA
3. develops and enhances critical thinking among learners.	4.86±0.18	SA
4. encourages minimal supervision on the part of the facilitator.	5.00±0.00	SA
5. provides opportunity for discipline and interaction among learners.	4.57±0.60	SA
Grand Mean	4.83±0.20	SA

Legend: Strongly Agree (4.50–5.00), Agree (3.50–4.49), Fairly Agree (2.50-3.49), Disagree (1.50–2.49), Strongly Disagree (1.00–1.49).
SD: Standard deviation

of thought-provoking questions because there are sections in the SLM in which the activities are procedural in nature. However, since the rest of the indicators achieved high ratings then it means that the activities are well-planned and well-designed to develop learner's creativity. Additionally, printed images and figures used are of excellent quality. One evaluator's suggestion was to add activities that will provide balance between the quality of activities and questions.

The evaluators also gave favorable ratings to the content of the SLM (*M = 4.83; SD = 0.22*), indicating that they strongly agree with all the indicators. This could be due to the inclusion of a number of paper-folding illustrations and activities that enhances the creativity, critical thinking and analytical thinking skills of the learners. The evaluators noted that with the method used in presenting the lessons in the SLM, learners can discover their hidden spatial abilities.

They have also observed that the approach suits the learners in the absence of teacher's supervision. Its development is timely especially that the students must be home-schooled during the pandemic.

The evaluators strongly agreed on the formulation of the objectives (*M=4.91; SD=0.12*). They gave excellent ratings on the indicators which specify that the objectives are stated in behavioral terms and that the projected learning activities are achievable. In other words, the learning activities are just within the capacity and interest of the learner. This also means that the evaluators found the objectives of the SLM to be within the acceptable standard in setting the instructional goals.

The SLM also got very good ratings in terms of suitability (*M=4.83; SD=0.18*) and usefulness (*M=4.83;SD=0.20*). Since two indicators for suitability received agree remarks: the provision of diverse activities with regards to level of difficulty and the presentation of lessons in the right sequence, these items will be taken into consideration during the SLM's revision. With two of its indicators, adaptability of the SLM to the level of the learners and relevance of its activities to the course objectives, getting excellent ratings, the material is still acceptable in terms of suitability. A suggestion from the evaluator that the targeted K-12 learning competencies be stated in every activity will also be considered in editing the SLM.

Finally, looking at the evaluators' responses on the usefulness of the SLM, they all strongly agreed that the developed material will require minimal supervision from the facilitator, serve as tool for motivation, promote independent learning, develop and enhance critical thinking skills and provide opportunity for discipline and interaction among the learners. It was noted that since the SLM is textual in nature then learner-learner interaction is not possible. However, the learner-content interaction may take place as the learner navigates and explores the various activities in the SLM. The overall rating of the validators shows validity of the developed SLM as to its usefulness.

Table 2. Summary of Experts' Validation

Criteria	Mean±SD	Verbal Description	Rank
Adequacy	4.74±0.32	SA	5
Clarity	4.71±0.32	SA	6
Content	4.83±0.22	SA	3
Objectives	4.91±0.12	SA	1
Suitability	4.83±0.29	SA	3
Usefulness	4.83±0.20	SA	3
Overall	4.81±0.06	A	

Legend: Strongly Agree (4.50–5.00), Agree (3.50–4.49), Fairly Agree (2.50-3.49), Disagree (1.50–2.49), Strongly Disagree (1.00–1.49). SD: Standard deviation

Table 2 presents the summary of experts' validation of the developed SLM. As shown in the table, the SLM received an excellent rating from the experts (*M = 4.81; SD = 0.06*) which implied that the validators strongly agreed with all the aspects of the learning material. Objectives (*M = 4.91*) ranked first, followed by content, suitability, and usefulness (*M = 4.83*), adequacy (*M = 4.74*), and content (*M = 4.71*). It is anticipated that since the activities are in visual form then students who fear math will find learning the concepts in this material more fun and in a concrete way. This agrees with the research findings of several studies (Evangelista et al., 2014; Ocampo, 2015; Pastor et al., 2015, as cited by Rogayan and Dollete, 2019). Tomlinson (1998) commented that the impact of instructional materials is achieved when materials have a noticeable effect on learners, that is, when the learners' curiosity, interest, and attention are aroused.

CONCLUSION

The study sought to determine the level of acceptability of a research-based supplementary learning material in geometry intended for grade six pupils. The developed SLM was found to be an excellent learning aid based on the evaluation of the experts. The evaluators are all in agreement that the instructional material possesses adequacy, clarity, suitability and usefulness. Moreover, they also gave very good ratings for its contents and objectives. The development of the SLM is timely as the country in the midst of the pandemic. It utilizes paper folding in its teaching of geometric concepts and thus promotes independent learning. In addition, the study did not find any significant difference between the perception of the evaluators as to the SLM's adequacy, clarity, content, objectives, suitability, and usefulness.

To heed DepEd's call for submission for evaluation of supplementary learning resources to support the implementation of the K- 12 Program, the following are recommended: (a) the developed "Paper Folding in Geometry" be evaluated based on students' perception on its format and content; (b) test the effectiveness of the SLM by conducting quasi-experimental research with grade six pupils as participants; and (c) modification of the said SLM based on the comments/suggestions/recommendations of the expert validators before forwarding it to DepEd for evaluation.

AUTHORS' CONTRIBUTION

S.F.G. wrote the entire paper as well as the developed learning material while M.G.L. did the statistical treatment and interpretation.

CONFLICTS OF INTEREST

No known conflict of interest.

REFERENCES

Auditor, E. & Naval, D. J. (2014). Development and validation of tenth grade Physics modules based on selected least mastered competencies. *International Journal of Education and Research*, *2*(12), 145-152.

Boakes, N. (2008). Origami-mathematics lessons: Paper folding as a teaching tool. *Mathitudes 1*(1), 1-9.

Cruz, C. L. I.., & Rivera, C. K. (2022). Development and validation of project-based module for selected topics in Biology. *International Journal of Educational Research &Amp; Social Sciences*, *3*(3), 1124–1137.

Dewi, I. & Haharap, M. (2016). The development of Geometri teaching materials based on constructivism to improve the students' mathematic reasoning ability through cooperative learning jigsaw at the Class VIII of SMP Negeri 3 Padangsidimpuan. *Journal of Education and Practice, 7*(2), 68-82.

Tan-Espinar, M. J. F., & Ballado, R. S. (2017). Content validity and acceptability of a developed worktext in Basic Mathematics 2. *Asia Pacific Journal of Multidisciplinary Research*, *5*(1), 72-84.

Evangelista, E. V., Ayuste, T. D., Belmi, R. M., Butron, B. R., Cortez, L. S., Evangelista, L. T., Fernandez, E. V. M., Garcia, G. S., Limson, B. M., Tondo, J. E. (2014). Development and evaluation of grade 7 and grade 8 biokit. *The Normal Lights*, *8*(2), 152-171.

Galicha, S. M. & Lazaro, M. S. (2019). *Contextualization of Geometric concepts through paper folding: Basis for development of instructional materials in Geometry*. Unpublished manuscript.

Instructional Design (2015). The ADDIE Model. http://www.instructionaldesign.org/models/addie.html

Kapur, R. (2019) *Development of teaching-learning materials*. Unpublished manuscript.

Llego, M.A. (2018). *A call for submission for evaluation of supplementary learning resources for public school libraries.* Teacherph. https://www.teacherph.com/supplementary-learning-resources/

Molano, R. R. (2020). Development and validation of learning material in statistics and probability. *ASEAN Journal of Basic and Higher Education*, *3*(1).

National Council of Teachers of Mathematics (2000). *Principle and standards for school Mathematic, United States of America: National Council of Teachers of Mathematics, Inc*. https://www.nctm.org/Standards-and-Positions/Principles-and-Standards/

Ocampo, C.A., de Mesa D. B., Ole, A. F., Auditor E., Morales, M. E., Sia, S. D., Palomar, B. C. (2015). Development and evaluation of PHYSICS MICROLAB (P6-Mlab) Kit. *The Normal Lights*, *9*(1), 134-158.

Pangesti, F. (2012). Pengembangan bahan ajar pendidikan berpikir (kritis dan kreatif) berbahasa Indonesia sma melalui pembelajaran lintas mata pelajaran. *Pendidikan Bahasa dan sastra, Journal of University of Malang*.

Pastor, C.J.M., Aranes, F. Q., Datukan, J. T., Duad, V., Bantang, J. O., Espinosa, A. A., Garcia, N., Marasigan, A. C., Camacho, V. I., Roque, A. P., Nueva España, R. C., Avilla, R. A., Ocampo, C. A. (2015). Initial validation of the chemistry microlab kit (Chem. µLab Kit) in facilitating learning of selected chemistry concepts for k-12 science. *The Normal Lights*, *9*(2), 180-204.

Rogayan, D.V. & Dollete, L.F. (2019). Development and validation of Physical Science workbook for Senior High School. *Science Education International*, *30*(4), 284-290. https://doi.org/10.33828/sei.v30.i4.5

Salcedo, R. E. (2016). Acceptability of a developed teaching module on selected writings of Jose Rizal. *Southeast Asian Journal of Science*, *1*(1), 90-97.

Tomlinson, B. (1998). *Materials Development in Language Teaching*(2nd ed.) Cambridge University Press.

Torrefranca, E. C. (2017). Development and validation of instructional modules on rational expressions and variations. *The Normal Lights*, *11*(1).

Wijaya, P.D. & Rohmadi, M. (2009). *Pragmatic Discourse Analysis: Theory and Analysis Study*. Surakarta: Yuma Pressindo.