

Development of Worksheets in Radical Expressions Embedded with Meranaw Cultural Elements for Grade 9 Learners

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ABSTRACT

This research developed learning tools in the form of a culture-based learner worksheet using 4D model. The purpose of this study is to obtain culture-integrated learner worksheets for Grade 9 learners to enhance skills and engage learners with learning math. The achievement test of the participants in the control and experimental group was compared to check if there is a significant difference between them. Based on the result of experimental group there is a statistically significant difference between the pre-test and posttest scores, whereas the control group showed minimal improvement. This suggests that the worksheets had significant impact on the learner's performance. This notable outcome of the worksheets was the positive impact on students' overall learning experience and self-efficacy.

Keywords: Culture-based worksheets, meranaw elements, radical expressions.

INTRODUCTION

The 2023-2024 Performance Report at Munai National High School identified radical expressions and word problems involving radicals as the most challenging topics for learners. Many learners struggle with these concepts, seeing radicals as abstract symbols rather than understanding their practical applications (Erlandson, 2013). The complexity of understanding radical expressions often lies in the abstract nature of these concepts, which can be difficult for learners to visualize and apply in problem-solving scenarios. This struggle may lead from the need to build a strong foundation in algebraic principles before understanding radicals, as supported by (Tazkiya, 2023), mastery of mathematical concepts is the basis for being able to solve mathematical problems with higher order thinking. However, learning radicals must be done not only because it is a prerequisite for more advanced topics in the tenth grade and senior high, but it develops logic and problem-solving ability that can be useful in actual life. For instance, (Annamalai, 2023) discussed that radicals are essential in algebra crucial for success in higher mathematics courses like calculus famous for computational science, an increasing cross-disciplinary field involving science, computing, mathematics, and its relation employ high computing capacity to make sense and solve the most complicated real-life challenges. Also, according to Schneider (2018), radicals are useful to learn in practice to know how to make measurements, finance and engineering, where radicals are used. Hence, making learning aids more available to meet the needs of learners dealing with such concepts is critical to the academic achievement and skillfulness of those learners. According to Ausubel, meaningful learning is a learning process that actively connects new material with learners' pre-existing knowledge. One of the ideas of creative and meaningful learning is implemented through culture-based learning. Education and culture are something that cannot be avoided in everyday life, because culture is a whole, applied in a society and education is a fundamental need for every individual in society (Ferry et al, 2024). The ethnomathematical approach, which combines culture and math instruction. The fundamental principle of ethnomathematics is the exploration and appreciation of the mathematics used in cultural groups. Ethnomathematics is the study of how different cultures perceive and apply mathematics, connecting abstract concepts to everyday life, as emphasized by D'Ambrosio (1995, 2006). While traditionally only focused on diverse mathematical practices, ethnomathematics also extends to art and design. The Okir design is a central motif in Meranaw culture, found in crafts like malong, landap, brassware, and house architecture (Aung et al, 2024). Using crafts of Meranaw as an example to measure actual objects, learners can calculate areas, volumes, Pythagorean theorem and radii. These are the key aspects of

understanding the application of lesson being applied in these cultural items to deepen their understanding of mathematics and fostering appreciation for their cultural heritage. Studies have found that when learners identify cultural representations with their learning materials, they are more likely to make a link with what they learn and easily retrieve the knowledge (Topan et al, 2024). When the same topics are learned with the use of the Meranaw cultural elements incorporated in the worksheet then it can be hypothesized that Meranaw students will have a better feel for it and thus will be most likely to engage themselves in learning algebra concepts actively. The study focuses on developing culture-based worksheets to enhance learners' achievement in radical expressions and problem-solving by incorporating culture-based worksheets, embedding cultural significance into the learning process to teach radical expressions to purposely selected Grade 9 learners.

METHODOLOGY

The researcher used qualitative and quantitative research design to develop and validate worksheets embedded with Meranaw cultural elements in radical expression for Grade 9 learners. Additionally, the worksheets embedded with Meranaw elements were developed using 4D (four-D model) developed Thiagarajan (1974). The 4D model is as the name suggests, encompasses four processes – Define, Design, Develop and Disseminate. The participants of this study compose of forty (40) Grade 9 learners from two (2) sections of Munai National High School for the school year 2024-2025. The experimental group consisted of 21 students who received the culture-based worksheets, while the control group with 19 students did not. All students participated in the study over a 3-week period, with the experimental group receiving the specific worksheets designed for this study. This study was conducted at Munai National High School is located in Barangay Tambo, Munai, Lanao del Norte, which is part of the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) it is a public secondary education in the area. The municipality of Munai is primarily Meranaw and predominantly Muslim.

RESULTS AND DISCUSSIONS

Process of Development of Worksheets in Radical Expressions Embedded with Meranaw Cultural Elements for Grade 9 Learners.

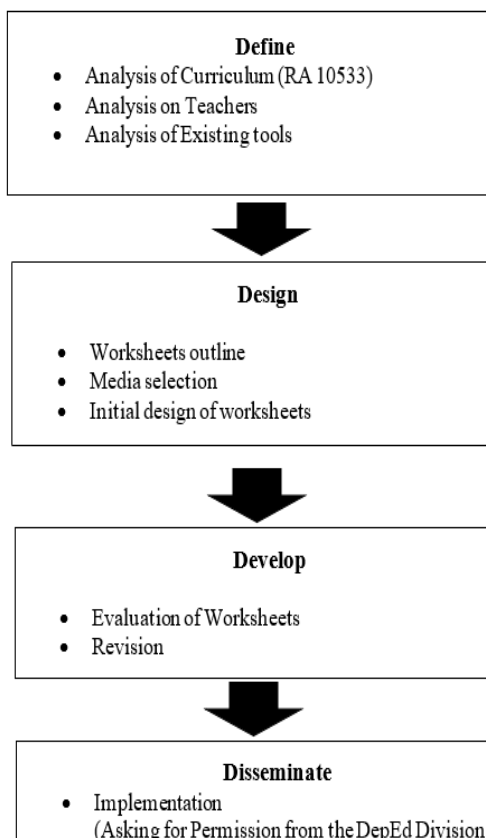


Fig. 1 Data Gathering Procedure

This research is Research and Development, using the developed Thiagarajan (1974) the 4-D model. The 4D design model for developing learning materials is a structured approach that consists of four main phases: Define, Design, Develop, and Disseminate.

Define Phase

Phase 1 of data gathering was the define part, this includes the analysis on curriculum, teachers' analysis and the analysis on existing tools. The three procedures were conducted in different ways. It contains indicators to check if the school's curriculum contextualized and localized to be more meaningful and relevant to students' lives. Areas examined include lesson plans, the school improvement plan, benchmarking practices, use of local culture and resources, teacher training, and learning materials. School administrators and a master teacher use the tool to check that localization guidelines are being followed and contextualization is integrated throughout curriculum delivery and assessment.

Analysis of Curriculum RA 10533

In this part, the research conducted the analysis of DepEd Order No. 32, s. 2015 shows that the K-12 curriculum give importance to contextualized lessons, integrating local culture into the learning process in Munai National High School. The researcher provides a survey on monitoring the contextualize and localized materials using the adapted questionnaire in line with DepEd Order No. 23 s. 2016. This approach represents an innovation in education, enhancing a deeper connection between students and cultural identity while preparing them for 21st-century challenges. Culturally relevant education, supported by studies such as those by D'Ambrosio (1995) enhances students' learning by teaching lessons within their cultural contexts.

Analysis on Teachers

In this part, the research conducted the least mastered competency in Grade 9 mathematics in the same school. It was found that, since the radical expressions is placed at the end of the quarter, some teachers chose to skip the lesson and move on to the next quarter, leaving the topic undiscussed. To address this, interviews were conducted to gather insights into teachers' strategies and approaches with learners. The goal was to identify how this lesson can be more effectively taught and how cultural context can be embedded to engage students better.

Analysis on Existing Tools

The materials that students must understand is radical expressions. However, based on surveys with teachers, it was found that they have not incorporated cultural context when teaching radical expressions. For instance, the DepEd Mathematics Learners Material for Grade 9 lacks integration with Meranaw culture, which could help contextualize and enhance students' understanding of these concepts by using artifacts within culture.

Design Phase

As for the Design, the researcher conclude in the analysis on the define part the design stage includes the topics were included based on the MELCs, radical has three subtopics in 2nd quarter. The researcher made a worksheets with these 3competencies (1) Operation on radical (2) Solving equation involving radical and (3) solves problems involving radicals. After considering the topic, the worksheets outline, media selection and the initial design of worksheets was evaluated determining the materials being produced embedded with cultural elements. Researcher was also conducted a survey on 8 people involving 4 adults and 4 students in the community about what cultural elements should be incorporated within worksheets. Based on the survey the identified cultural elements that the community most familiar are: Okir, Meranaw literacy, and crafts. Okir was used in the first topic of the lesson which is the operation on radical, second, the literacy heritage which is kapagantuka and pananaroon. The competency invoved are translating phrases into expression and solving equation involving radical. The worksheets are decoding a message in Meranaw. Third, is cultural craft of Meranaw, Malong/ Landap, Kulintang, Baul and etc. These Meranaw crafts were used to apply radical expression in cultural context that is relatable to the learners.

Develop Phase

As for the Develop, produce worksheets that is suitable for Meranaw learners based on expert comments and suggestions. This stage includes the evaluation from the design phase: worksheets outline, pre-evaluation of the developed worksheets revealed a on the part of “worksheet outline” Moderate (Satisfactory) rating with a weighted mean score of 3.6767. This indicates that while the worksheets are generally satisfactory. Specifically, the clarity of instructions, the precision of concept delivery, the appropriateness of materials, and the potential to enhance students' thinking skills could be further developed to achieve a higher level of effectiveness. Media selection, received a Moderate (Satisfactory) rating with a weighted mean score of 3.75.

The layout, font choices, and format received Moderate (Satisfactory) ratings which suggest for more improvement. The initial design of worksheets received a Moderate (Satisfactory) rating with a weighted mean score of 3.75. The evaluators suggested that the worksheets could be improved by more effectively connecting the cultural elements to the mathematical concepts, making the cultural context more relevant and meaningful to the learning objectives.

LESSON 3 Solving Problems Involving Radicals

Worksheet 5:

Direction: Use mathematical formulas to find the traditional Maranao items. This activity connects geometry with real-life applications and cultural significance.

1. The Torogan is the traditional house of Maranao royalty, and it often features intricate Okir designs (traditional carvings). You will use the Pythagorean theorem to find a missing side of one of these triangular Okir carvings.

Problem: In one of the triangular Okir patterns, the height of the triangle (Panolong) is 56 inch, and the base is 88 inch. Find the length of the diagonal (hypotenuse).



Solution:

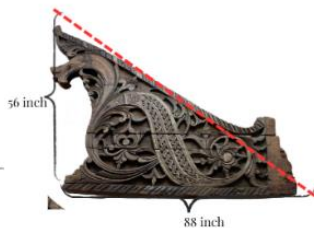


Fig. 2 Sample problem with Meranaw craft

Worksheet 5:

Direction: Use mathematical formulas to find the volume of traditional Maranao items. This activity connects geometry with real-life applications and cultural significance.

2. A baul is a traditional wooden chest or box used for storing items. It is in the shape of a rectangular prism.

Problem: A Maranao baul has a length of 120 cm, a width of 6 cm, and a height of 40 cm. Calculate the volume of the baul.



Fig. 2 Sample problem with Meranaw craft

Worksheet 3: Guess Me!

Direction: Write an algebraic expression for each word phrase and guess the riddles in Meranaw.

“Piyamasa aku na gadong, kiyan aku na mariga, inuta aku na maitum”

The square root of the sum of a number and 16 is 6. What is the number? N	The square root of a number increased by 3 equals 4. Find the number. O	The square root of the product of a number and 5 is equal to 15. Find the number. L
The square root of the difference between a number and 4 is 10. What is the number? M	The square root of twice a number is 10. What is the number? R	The square root of the sum of twice a number and 1 is 9. What is the number? E
The square root of four times a number minus 8 equals 6. What is the number? A	The square root of a number and 12 equals 6. Find the number. W	The square root of three times a number plus 1 is 10. What is the number? T

Figure 3. Sample problem with Kapagantuka

Worksheet 3: Am I Quote?

“Piyamasa aku na gadong, kiyan aku na mariga, inuta aku na maitum”

24 11 33 40 50 104 40 45 1 20

Reflections:

1. What steps did you use to solve the activity?
2. What mathematical concepts are important in simplifying expressions with rational exponent?
3. Did you encounter any difficulties while solving? If yes, what are your plans to overcome those difficulties?
4. After completing the worksheet, how do you feel about combining mathematical operations with cultural activities? Did you feel more motivated or challenged while working on this task? Why or why not?

Figure 4. Sample of reflections

Disseminate Phase

As for the Disseminate, the pre-test and posttest of experimental and control group were analyzed first its normal distribution, then the researcher used t-test to compare the difference of two (2) groups. The experimental group showed significant improvement in posttest after the worksheets.

Initially, all 21 students from experimental group were at the Beginning level in the pre-test, but in the post-test, 6 remained at the Beginning level, 12 advanced to Developing, and 3 reached Approaching Proficient.

This progression highlights the effectiveness of the culture-based worksheets in moving most students out of the lowest performance category. In contrast, the control group showed minimal improvement. Pre-test results placed 19 students at the Beginning level and 3 at Developing. In the post-test, 15 remained at the Beginning level, 3 stayed at Developing, and only 1 advanced to Approaching Proficient, indicating minimal progress without the culture-based worksheets developed.

The post-test results confirm that the worksheets significantly enhanced learners' performance, demonstrating their positive impact on learners' academic achievement

TABLE I Achievement Result of Experimental and Control Group

Experimental Group						
Interval	Pretest			Posttest		
	f	%	Remarks	f	%	Remarks
27-30	0	90-100	Advance	0	90-100	Advance
24-26	0	85-89	Proficient	0	85-89	Proficient
21-23	0	80-84	Approaching Proficient	3	80-84	Approaching Proficient
18-20	0	75-79	Developing	12	75-79	Developing
0-17	21	0-74	Beginning	6	0-74	Beginning
Control Group						
Interval	Pretest			Posttest		
	f	%	Remarks	f	%	Remarks
27-30	0	90-100	Advance	0	90-100	Advance
24-26	0	85-89	Proficient	0	85-89	Proficient
21-23	0	80-84	Approaching Proficient	1	80-84	Approaching Proficient
18-20	0	75-79	Developing	3	75-79	Developing
0-17	19	0-74	Beginning	15	0-74	Beginning

CONCLUSION AND RECOMMENDATION

The study successfully developed culture-based worksheets for Meranaw learners, focusing on radical expression using 4D model. The Define phase revealed gaps in existing materials, teacher practices, and curriculum integration of culture that makes math relevant and meaningful. The Design phase incorporated topics based on Most Essentials Learning Competencies (MELCs) and integrated cultural elements like Okir, Meranaw Literacy, and crafts. During the Developed phase, expert evaluation rated worksheets as satisfactory. The Disseminate phase showed significant improvement in the experimental group performance compare to control group. This confirms the effectiveness of worksheets. The researcher recommends to enhance the curriculum materials by integrating local culture to promote contextualized learning and cultural appreciation. The worksheet should be refined to address more connection between cultural elements and mathematical concepts to maximize their effectiveness. Teachers should receive training to effectively implement contextual materials and foster engagement. Future studies should expand to other grade levels and cultural context to validate further and explore the impact of culturally integrated learning on learner's outcome.

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