DEVELOPMENT AND EVALUATION OF A PROPOSED WORKTEXT IN SOLID MENSURATION

Erovita Teresita Bacud Agustin
Doctor in Mathematics Education

ABSTRACT

The main purpose of this study is to develop and evaluate a proposed worktext in Solid Mensuration along the quality of elements: course content, manner of presentation and usefulness of the material. The participants consisted of 50 freshmen engineering students from the University of Saint Louis, Summer 2016. A quasi – experimental method was used to determine whether the use of worktext in teaching and learning Solid Mensuration will improve students' understanding and performance. The data were collected from two groups (control and experimental), analyzed and were interpreted using mean, standard deviation and weighted mean and independent samples t-test. The findings showed that the proposed worktext in Solid Mensuration is effective in enhancing students' understanding of the concepts in Solid Mensuration. Also, the experts and the students have similar assessment along the different quality of elements of the proposed worktext; therefore the proposed worktext can be utilized as a supplementary instructional tool by both the students and teachers for facilitating teaching and learning process in Solid Mensuration.

***Keywords**: Development, evaluation, worktext, solid mensuration*

INTRODUCTION

Solid Mensuration particularly in college is highly important in engineering and architecture applications. This course is used extensively in the practice of engineering. Knowledge of this course is a necessity for engineers in any project construction. Understanding objects in three-dimensional space helps engineers create models and scenarios and solve problems mathematically before actually using or building any resources. Some lessons in Solid Mensuration are too complicated to analyze, so it is difficult for the students to understand the subject (Lavador and Calderon, 2012). Indeed, teaching Solid Mensuration is one of the most challenging tasks among Mathematics teachers.

Solid Mensuration which is one of the major Mathematics courses in the engineering curriculum at the University of Saint Louis is a prerequisite of Differential Calculus. For the past years, students were exposed to the traditional method of learning the course. The lessons were presented in a lecture format where the teacher explains new concepts and then provides examples of the new concept. The only instrument of instruction was a textbook. As cited by Gak (2010), a textbook is used as a standard source of information for formal study of a subject and an instrument for teaching and learning. However, the researcher, with her years of experience teaching Solid Mensuration, observed that with this method and medium of instruction, majority of the students consider the course to be difficult which consequently caused them to perform poorly in the course. As a result, an increasing number of engineering students at the end of the grading period get a failing grade as indicated in the percentage of failures of 14.61% from SY 2011 – 2012 to SY 2015 – 2016 Thus, the teaching and learning of Solid Mensuration should be further improved.

With the current shift from Inputs-based Education (IBE) to Outcomes-based Education (OBE), particularly in the tertiary level, it is necessary for the teachers to carefully design activities placing the students at the center of all educational planning. Teachers handling Solid Mensuration must therefore use instruction suited to the level of understanding of their students. They must employ current instructional materials as tools to make instruction more effective,

efficient and appealing to the learners. One way to enhance instruction is to provide the learners with carefully developed lessons. Teachers must design activities that engage students in the learning process, activities that build mastery of concepts in Solid Mensuration and consequently, activities that support learners with varying levels of ability and skills.

Numerous studies over the years have introduced a range of instructional materials such as worktexts, workbooks and modules to meet the learners' needs and equip them with skills required for their level (Adora, 2014).

Selga (2013) explained that worktexts are helpful in keeping one child occupied while working with another. As revealed in her study, the proposed worktext was found to be valid. She further concluded that worktexts contribute to the achievement of specific objectives of the subject and provide activities for the development of higher cognitive skills. Worktexts of better quality include problem-solving exercises that encourage higher-level thinking in addition to the traditional fill-in-the-blank and define-the-term exercises (Knapp, 2006).

Auditor and Naval (2014) addressed the need to improve the performance of all students across schools as manifested in the results of the 2012 National Achievement Test (NAT). The main purpose of their study was to develop and validate physics modules based on the least mastered competencies and assess the impact of the developed modules on students' knowledge acquisition. As revealed in their study, the developed modules were found acceptable for the 10th grade physics students. Also, the developed set of modules was found to be effective in terms of knowledge acquisition. Thus, they recommended that the adoption of the developed module can be a useful tool for teaching and learning basic physics.

The integration of enrichment activities such as computer animations in the proposed instructional material generated a more innovative and interesting learning environment. Thus, through this material, students found Mathematics learning more meaningful and interesting (Dacanay, 2010).

Worksheets are materials by which students are given transaction steps regarding what they are supposed to learn. Also, they include activities which give the students main responsibility in their own learning. Thus worksheets are known to help students gain scientific process skills such as setting up experimental mechanism, recording data, interpreting the data, and so on so that they can conceptualize the concepts in their mind (Kurt & Akdeniz , 2002).

Books in Solid Mensuration which are available in the university library at the University of Saint Louis (USL) are limited, most of which are written by foreign authors and some are even old or outdated. The contents of the textbooks are not tailored to the specific attributes and interests of the engineering students at USL. The examples presented in the textbooks are sometimes irrelevant to the students and often do not reflect the interests and needs of students. The researcher observed that foreign books used terms that are not easily understood by students. In particular, students prefer terms that are commonly used in the local setting. She also noticed that there were books which contain limited examples having shortcuts in the discussion.

Realizing the need for a more effective supplementary material, the researcher developed a simplified instructional material in Solid Mensuration to enhance students' learning of the subject and to stimulate their interest in the subject for better achievement.

Statement of the Problem

The study aimed to determine the effectiveness of a proposed instructional material in the teaching and learning of Solid Mensuration.

Specifically, it sought to answer the following:

1. What are the pre-test mean performances of the students in the control and experimental groups?
2. What are the post-test mean performances of the students in the control and experimental groups?
3. Is there a significant difference between the:
    3.1 pre-test performances of students in the control and experimental groups?

3.2 post-test performances of students in the control and experimental groups?
3.3 pre-test and post-test performances of students in the control and experimental groups?

4. What is the assessment of the mathematics experts along the quality of elements of the proposed instructional material in Solid Mensuration in terms of:
   4.1 course content
   4.2 manner of presentation
   4.3 usefulness of the material?

5. What is the assessment of the students along the quality of elements of the proposed instructional material in Solid Mensuration in terms of:
   5.1 course content
   5.2 manner of presentation
   5.3 usefulness of the material?

6. Is there a significant difference on the assessment of the instructional material in Solid Mensuration between the experts and the students in terms of :
   6.1 course content
   6.2 manner of presentation
   6.3 usefulness of the material?

METHODOLOGY

Research Design

The research design used in the study was quasi-experimental. Specifically, a pre-test and post-test of matched groups in which two different learning environments were compared to determine the effectiveness of the proposed worktext in Solid Mensuration. The experimental group was taught using the proposed worktext while the control group was taught using the textbook in Solid Mensuration.

Group	Pre-test	Approach	Post-test
E	O1	X1	O2
C	O3	X2	O4

Note. E = Experimental group; C = Control group; O1 = pre-test of the experimental group; O2 = post-test of the experimental group; O3 = pre-test of the control group taught; O4 = post-test of the control group; X1 = use of proposed worktext in teaching Solid Mensuration; X2 = use of textbook in teaching Solid Mensuration

Participants of the Study

The participants of the study were composed of two groups.

Student-participants. Two classes of Solid Mensuration were offered last Summer 2016 to freshmen engineering students in the University of Saint Louis. Twenty-five participants were taken from each of the classes and were grouped into two – the experimental group and the control group. The participants of the two groups were identified and carefully matched based on their average grade in College Algebra and Plane & Spherical Trigonometry, which are pre-requisites of Solid Mensuration. Students with an average grade of 76 – 90 were included in the study. Result of the pre-test administered before the conduct of the study was also considered in the selection. The control group was randomly assigned to a class from 7:00 AM to 8:30 AM, MWF and from 8:30AM to 10:00AM, TTHS while the experimental group was randomly assigned to a class from 8:30AM to 10:00AM, MWF and from 7:00 AM to 8:30 AM, TTHS.

Experts. This group was composed of 3 Mathematics instructors, 3 Engineering Sciences instructors and 3 external experts. The Mathematics instructors and Engineering Sciences instructors were faculty members from the University of Saint Louis while the external experts were from the University of Cagayan Valley (UCV), St. Paul University Philippines (SPUP) and USL – High School Department. This group assessed the proposed worktext in Solid Mensuration in terms of content, manner of presentation and usefulness of the material.

Instrumentation

The research instruments that were used in this study are the questionnaire and pre-test and post-test. The results were supplemented with data from an informal interview.

The questionnaire on worktext evaluation tool was administered to the teacher-participants to assess and to evaluate the quality of the proposed instructional material in terms of content, manner of presentation and usefulness of material. The same set of questionnaire was administered to the experimental group after the try-out period of the material.

The worktext evaluation tool that was used in the study was adopted from the evaluation tool used by Romero (2008) in his study "The Development and Validation of a Proposed Worktext in Biostatistics". He aimed to assess the effectiveness of a Proposed Worktext in Biostatistics in terms of content, manner of presentation and usefulness of material.

The main instrument used in this study was the pre-test/post-test administered to the student-participants. The pre-test/post-test was piloted for validation to the students who already finished Solid Mensuration. The pre-post test was piloted for validation to the students who already finished Solid Mensuration. The pre-test/post-test consisted of a 45-item multiple choice test that specifically measured the effectiveness of the proposed worktext in Solid Mensuration and the competencies required of students in Solid Mensuration. A table of specification was prepared for fair distribution of items among the topics in Solid Mensuration.

Unstructured/informal interviews were likewise conducted with the experts to elicit comments and suggestions to further improve the proposed worktext in Solid Mensuration.

The initial draft of the proposed worktext consisted of six chapters. Each chapter included the following parts (1) Topic which is the lesson to be learned; (2) Learning Outcomes which describes what the learner should know and be able to do at the end of each

lesson; (3) Concept Development which allows students to investigate, explore and discover concepts on their own; (3) Key Concepts which is a summary of ideas or concepts drawn from students' discovery, investigation and exploration; (4) Guided Practice which serves as an approach to instruction where the teacher leads the activity but solicits help from students; (5) Self-Test which consists of items for additional drills and practice; and (6) Evaluation to assess students' learning. The format of the worktext was carefully designed to easily capture the attention of the learners.

Data Gathering Procedure

The research procedure followed three phases:

Pre-treatment Phase

The researcher sought permission from the Academic Dean of the School of Engineering, Architecture and Interior Design (SEAID) with the approval from the University President for the conduct of the study. In the first phase of USL, the researcher made use of the course syllabus in Solid Mensuration to review the competencies of the course as basis for formulating the learning outcomes. Also, survey of books available at the university library, informal interviews with the experts, library work and use of internet were employed by the researcher for concept development and drill activities in order to come up with the initial draft of the proposed worktext in Solid Mensuration. The researcher adopted the format used by Batulan (2003) but modified some parts to wit: Topic, Learning Outcomes, Key Concepts, Guided Practice, Self – Test and Evaluation. Lessons were organized based on the course syllabus to ensure that the content is sufficient and the presentation of the examples is progressive. The initial draft of the proposed worktext was presented to experts to elicit suggestions and comments regarding the course content, manner of presentation and usefulness of the material.

Refinement in the proposed worktext was made based on the evaluation, comments and suggestions of the experts.

A pre-test was administered to both experimental and control

group before the use of the proposed worktext to initially determine the extent of knowledge on the topics to be introduced to them.

Treatment Phase

The proposed worktext was utilized by the experimental group for the duration of 33 hours for a total of 22 meetings. The control group was taught using the textbook in Solid Mensuration for the same duration of time. Throughout this period, the lessons, references through internet sites for additional information and learning conditions were the same for both groups. However, parallel items in the quizzes and assignments were administered.

Post-treatment Phase

After the topics had been taught through the proposed worktext in the experimental group and textbook in the control group, the same test was re-administered to the two groups at the same time as post-test. Their scores were evaluated and compared to determine if there was any significant difference.

A worktext evaluation tool was administered to the experimental group and to the experts to evaluate the quality of the proposed worktext in Solid Mensuration in terms of course content, manner of presentation and usefulness of the material.

Data Analysis

The data gathered were analyzed using the following descriptive statistics:

Weighted Mean. The weighted mean was used to determine the mean assessment of the participants on the proposed instructional material in Solid Mensuration in terms of content, manner of presentation and usefulness of the material. The following scale was used to interpret the weighted mean.

Range	Qualitative Description
4.20 – 5.00	Very Highly Evident/Excellent/Very Useful
3.40 – 4.19	Highly Evident/Very Good/Useful
2.60 – 3.39	Evident/Good/Moderate
1.80 – 2.59	Less Evident/Fair/Less Useful
1.00 – 1.79	Least Evident/Poor/Not Useful

Mean. The mean was used to answer the problems posed in the study such as the pre-test and post-test performances of the two groups.

Pre-posttest Results Scale. This scale which is patterned from Dacanay (2010) was used in interpreting the pre-posttest results of the students.

Range	Qualitative Description
40 – 45	Excellent
34 – 39	Very Good
28 – 33	Good
22 – 27	Fair
0 – 21	Poor

T-test. The t-test for independent samples was employed to test the significant difference between:

1. pretest scores of the control group and the experimental group
2. posttest scores of the control group and the experimental group
3. the assessment of the participants (experts and experimental group) on the proposed instructional material in Solid Mensuration in terms of Course Content, Manner of Presentation and Usefulness of the Material.

The t–test for dependent samples was used to test for significant difference between:

1. pretest and posttest scores of the control group
2. pretest and posttest scores of the experimental group

RESULTS AND DISCUSSION

Pretest and Posttest Mean Performances of the Control and experimental groups

Both groups had a poor performance in the pretest. The control group had a fair performance in the posttest while the experimental group had a very good performance in the posttest.

Test for Significant Difference in the Pretest Mean Performances of the Control Group and the Experimental Group

There is no statistically significant difference in the pretest mean performances of the control group and the experimental group.

Test for Significant Difference in the Posttest Mean Performances of the Control Group and the Experimental Group

There is a statistically significant difference in the posttest mean performances of the control and experimental group.

Test for Significant Difference in the Pretest and Posttest Mean Performances of the Control and Experimental Groups

There is a statistically significant difference in the pretest and posttest mean performances of the control and experimental groups.

Assessment of the Mathematics Experts Along the Quality of Elements of the Proposed Instructional Material in Solid Mensuration

Course Content

The assessment of the experts in terms of the course content was very highly evident.

Manner of Presentation

The assessment of the experts in terms of the manner of presentation was excellent.

Usefulness of the Material

The assessment of the experts in terms of the usefulness of the material was very useful.

Assessment of the Experimental Group After the use of the Proposed Worktext Along the Quality of Elements of the Proposed Instructional Material in Solid Mensuration

Course Content

The assessment of the experimental group in terms of the course content was very highly evident.

Manner of Presentation

The assessment of the experimental group in terms of the manner of presentation was excellent.

Usefulness of the Material

The assessment of the experimental group in terms of the usefulness of the material was very useful.

Test for Significant Difference Between the Assessment of the Mathematics Experts and the Experimental Group Along the Quality of Elements of the Proposed Instructional Material in Solid Mensuration

Course Content

There is no statistically significant difference between the assessment of the mathematics experts and the students in terms of the elements in the course content.

Manner of Presentation

There is no statistically significant difference between the assessment of the mathematics experts and the students in terms

of the elements in the manner of presentation.

Usefulness of the Material

There is no statistically significant difference between the assessment of the mathematics experts and the students in terms of the elements in the usefulness of the material.

CONCLUSION

The proposed worktext in Solid Mensuration is effective in improving students' performance. Effective and well-developed instructional materials are tools which include active learning and enhance students' conceptual understanding. A well developed worktext should be appropriate to the level and needs of the students. The following quality of elements in terms of course content, manner of presentation and usefulness of the material were assessed by the experts and students as very highly evident, excellent and very useful, respectively. Moreover, the worktext which contains information and directions that are clearly written and explained, may help the learners enhance their own knowledge, thus, making learning more significant, enjoyable, meaningful and interesting.

RECOMMENDATIONS

From the foregoing conclusions, the following are the recommendations:

1. Mathematics teachers are encouraged to develop their own instructional materials not only in Solid Mensuration but also in other Mathematics subjects to facilitate teaching and learning.
2. The researcher may further validate the proposed worktext by a large pool of experts and may be utilized or tried-out to a large group of students to further test its effectiveness.
3. The University should consider the proposed worktext as an instructional material and be used in the teaching-learning process of Solid Mensuration.
4. The administration should financially support teachers who have the potential in developing instructional materials.

5. Future researchers may conduct similar studies that focus on the learning outcomes of the students in the course.
6. The administration should support the utilization of the proposed worktext in the University.

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