

# Validation of the NCBTS-Based Mathematics Proficiency Test (MPT) For Pre-Service Elementary Teachers

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## Abstract

*Universities and colleges are beginning to search for mutually beneficial programs that would assist the development and assess the proficiency of pre-service teachers. The development of the National Competency Based Teacher Standard (NCBTS)-based Mathematics Proficiency Test (MPT) was a response to the objective of Teacher-Education programs of designing valid and reliable assessment strategies and evaluative techniques that shall provide relevant feedback for better teaching and training of effective elementary and secondary teachers.*

*This descriptive-evaluative study gives evidence on the face validity, and practicality and efficiency of the developed MPT as a standard assessment tool. Findings revealed that the directions, test content, mechanical make-up, and scoring characteristics of the MPT are outstandingly valid as perceived by both the pre-service elementary teachers and the mathematics professors. The two groups of respondents did not differ significantly ( $p < 0.05$ ) in their evaluations as to mechanical make-up and practicality and efficiency of the MPT. It was also noted that the practicality and efficiency of the MPT was outstanding as strongly agreed by the two groups of respondents. Improvements made on the MPT for final packaging are based on the suggestions of the respondents.*

## Introduction

Universities and colleges are beginning to search for mutually beneficial programs that would assist the development and assess the proficiency of pre-service teachers. Increased accountability has caused schools to re-examine current programs and use of resources. Schools are requiring evidence of student learning as a result of pre-service teacher programs in the schools (Clark, 2012).

The Sorsogon State College (SSC) is a primary higher education institution offering and producing teachers with degrees in Bachelor of Elementary Education and Bachelor of Secondary Education. Its Teacher-Education program aims to provide for the development and training of effective elementary and secondary teachers. In addition, some of the commitments of the program are: to create standard, updated, innovative and alternative instructional techniques, teaching methods, approaches and learning strategies; to design valid and reliable assessment strategies and evaluative techniques that shall provide relevant feedback for better teaching and learning; and to disseminate research findings relevant to teacher education through instruction, extension and production services (ssceducation.weebly.com).

Cognizant with the goals and objectives of the SSC Teacher-Education programs, one of the

innovations that were realized is the development of the National Competency-Based Teacher Standards (NCBTS)-Based Mathematics Proficiency Test (MPT) primarily intended for the pre-service elementary teachers. The NCBTS MPT has been found to be a valid and reliable instructional device that would assess the proficiency of pre-service elementary teachers on basic mathematical skills. This is aligned with the NCBTS table of specifications for the Licensure Examination for Teachers (LET). Its content validity has been established by mathematics jurors in the field. Moreover, the Cronbach's Alpha value of 0.78 and two-weeks time interval test-retest reliability coefficient value ( $r = 0.85, p < 0.01$ ) indicate high degree of reliability of the test.

Rico (2011) stresses that one of the primary roles of the classroom teachers is the evaluation of educational outcomes to improve teaching and learning process. Thus, evaluation should utilize appropriate, valid, and reliable instruments that can gather sufficient data on whether or not the teacher achieved his or her instructional objectives. Test developers must have clear objectives before writing the test because accomplishing a test with characteristics of a standard assessment tool is a tedious process.

The developed MPT covers arithmetic and measurements, elementary algebra, geometry, and probability and statistics. This content is aligned with the Department of Education's K to 10 Mathematics Curriculum which provides a solid foundation for Mathematics at Grades 11 to 12 (K to 10 Curriculum Guide, 2011). Thus, its development may help the pre-service teachers not only to prepare for the licensure examination but more importantly, in teaching the mathematics subject at the basic education level.

Teacher-Education curriculum is designed to prepare professional teachers for practice in primary and secondary schools in the Philippines. In addition, teachers' content knowledge is the key factor to students' academic success in today's classroom ([www.k-12prep.math.ttu.edu](http://www.k-12prep.math.ttu.edu)). However, if pre-service teachers do not feel competent with their elementary mathematics content, they will not have the confidence to teach this content to students. Swetz (2003) affirmed the fact that a sound knowledge of basic mathematical concepts is required of any elementary school teacher. Teachers cannot teach the subject correctly if they do not know the subject.

In the light of observed deficiencies of the pre-service teachers' mathematics content, the NCBTS-Based Mathematics Proficiency Test (MPT) was developed as an assessment tool that identifies the competencies that need to be enhanced by pre-service teachers in general education mathematics standards. Thus, this study was conducted to validate the developed MPT and to determine its practicality and efficiency as an assessment tool which could be used by the Teacher Education Institutions (TEIs) as bases for intervention program for the prospective elementary teachers.

## Objectives

The main objective of this study was to provide evidence on the face validity, practicality and efficiency of the NCBTS- Based Mathematics Proficiency Test (MPT) for the pre-service elementary teachers. The following are the specific objectives of the study: (1.) Determine the face validity of the MPT as perceived by the mathematics instructors/professors and the pre-service teachers in terms of directions, test content, mechanical make-up, and scoring characteristics; (2. ) Determine the practicality and efficiency of the MPT as an assessment tool; (3.)Test whether there is a

significant difference in the evaluation of the two groups of respondents on the face validity and practicality and efficiency of the MPT; and (4.) Improve the MPT for final packaging based on the suggestions of the respondents.

## The Mathematics Proficiency Test (MPT)

The MPT covers the general education mathematics subjects of the New Teacher Education Curriculum under CMO 30, s. 2004 composed of Fundamentals of Mathematics (Math 1) which deals on Arithmetic and Measurements, Plane Geometry, and Elementary Algebra; and Contemporary Mathematics (Math 2) which covers Probability and Statistics. The competencies were adapted from the table of specifications of the National Competency-Based Teacher Standards (NCBTS) for Licensure Examination for Teachers (LET).

This multiple-choice type of test comprises 80 items divided into four components as follows: (1.) 26 items or 32.50% on Arithmetic and Measurements, (2.) 16 items or 20% on Plane Geometry, (3.) 19 items or 23.75% on Elementary Algebra, and (4.) 19 items or 23.75% on Probability and Statistics with greater emphasis on comprehension and application. The items for each competency included in the developed MPT were categorized in terms of Bloom's taxonomy for the classification of objectives under cognitive domain. This proficiency examination is comparable to a two-hour written multiple choice type final examination in a course which requires 75% or better equivalent grade. The main purpose of this material is to determine the proficiency including the strengths and areas that need further improvement in general education mathematics of the prospective elementary teachers as bases for intervention so as to prepare them for teaching the content as mathematics teacher in the field.

There were two overlapping phases in the accomplishment of the Mathematics Proficiency Test (MPT): (1.) development phase, and (2.) validation phase. The development phase follows four stages: (a.) planning the test, (b.) preparing the test, (c.) trying out the test, and (d.) analyzing and revising the test. The validation phase included the following events/activities: (a.) content validation through the table of specification (TOS), (b.) content validation by experts, and (c.) dry-run or the try-out stage. The try-out was done twice. The first try-out for the first draft which consisted of 120 items was administered

to the second-year pre-service teachers of Sorsogon State College Bulan Campus for the purpose of revising the MPT and determining the number of items to constitute the final draft of the test. After item analysis, the second try-out was conducted for the second draft which consisted of 80 items after discarding the very easy and very difficult items. This stage was done for the purpose of improving the MPT and the efficiency in the test administration.

To strengthen the conduct of the second try-out at SSC Bulan Campus, this test was also administered to the 164 second year pre-service elementary teachers of the SSC Sorsogon City (Main Campus). Considering all types of learners based from this result, it was decided in the research process that the test will for 2 hours or 120 minutes including giving of the general directions.

## Methodology

This study is a descriptive-evaluative method type of research since it is concerned with the assessment of the characteristics of the developed Mathematics Proficiency Test (MPT) as a standard instrument. The study involves both the mathematics instructors/professors and the pre-service elementary teachers of the main campus in the research process.

Forty-one of 164 or 25% of pre-service teachers from four sections who were involved for the last try-out of the test were considered as sample to evaluate the characteristics of the MPT in terms of its face validity and practicality and efficiency. They were considered in the study because they could give an accurate and meaningful evaluation of the MPT since they have already utilized it. Systematic sampling technique per section was used in the selection of the 41 pre-service teachers sample which was done by listing according to their scores in the test so that there will be representative samples in the upper, middle, and lower group to avoid biases. On the other hand, total enumeration for instructors/professors respondents was considered in this study. Zulueta and Perez (2010) stressed that a minimum of 20% may be required for a smaller population as sample of the study which the present study surpass this minimum requirement.

The main instrument used in this study was the Assessment Form for the Developed Mathematics Proficiency Test (MPT). This was prepared to find

out the perceptions of both the mathematics professors/instructors and pre-service teachers on the face validity and the practicality and efficiency of the MPT. The five point Likert Scale was used on respondents' agreement as follows: 5 - Strongly Agree, 4 - Agree, 3 - Moderately Agree, 2 - Disagree, and 1- Strongly Disagree. This assessment form has been constructed by the researcher itself guided by the principles of test construction. This has been rated by the experts in different fields as very good and an appropriate tool in evaluating the MPT.

The evaluation of the two groups of respondents on the face validity, and practicality and efficiency of the MPT was treated using frequency count and weighted mean. The adjectival description and interpretations of validity was adapted from the study of Pontiveros (n. d.). To test whether there is a significant difference in the evaluation of the two groups of respondents; *t*-test for independent data was utilized.

## Results and Discussions

### *Face Validity of the NCBTS-Based Mathematics Proficiency Test*

Table 1 shows the face validity of the NCBTS-based MPT based from the evaluation of the mathematics professors/instructors and pre-service teachers. Face Validity pertains to whether the test "looks valid" to the examinees who took it. This includes the characteristics in terms of test directions, test content, mechanical make-up, and scoring. This was determined by averaging the level of agreement of the two groups of respondents on each mentioned indicator of face validity.

In terms of test directions, both the mathematics instructors/professors and pre-service teachers strongly agree on its characteristics as revealed by the mean rating of 4.89 and 4.59, respectively. These result to 4.74 average mean rating of the two groups of respondents for the MPT directions interpreted as outstandingly valid. This means that the test directions of the MPT satisfied both the need of the instructors/professors and students in its test administration. Aquino and Garcia (1974) assert that good tests provide clear, unambiguous, specific, and complete instructions which will help the examiner conduct the test without undue effort on the measurement of examinees behaviour. The ease of administration must be considered in terms of the

test administrator and the pupils taking the test. Thus, it is essential to have clear and complete directions in any standardized assessment tool as one of the factors in obtaining a valid and reliable test results.

Along test content characteristics, the instructors/professors strongly agree (4.97) while the pre-service teachers agree (4.47) that the test content suits the coverage of the general education mathematics which is reflected in the NCBTS table of specification for the licensure examination for teachers. The result show that the instructors/professors provide better feedback on the test content characteristics of MPT that it could really measure the pre-service teachers' competencies along the specific coverage reflected in the NCBTS table of specification, since they are more aware on this criterion than the pre-service teachers. Kubiszyn and Borick (2007) stress that a test has validity evidence if it measures what it intends to measure. The validity can also be determined with reference to the particular use or purpose for which the test is being considered.

Along with this, the pre-service teachers affirmed the fact that they wanted their proficiency in general mathematics be assessed aligned to the national standards that would give evidence whether they are ready for the next level of their mathematics learning. The average mean rating of 4.72 revealed that the test possesses outstandingly valid test content which means that the MPT coverage reflects the target content standards as perceived by the respondents. Santrock (2004) emphasizes that assessment instrument is fair when teachers have developed appropriate learning targets, provide competent content and instruction to match those targets, and chosen assessments that reflect the targets, content, and instruction.

Another important characteristic of a standardized test that would affect the validity and reliability of the results is the mechanical make-up.

Calmorin (2004) describes that a good measuring instrument should be printed clearly in appropriate size and spacing for certain type of examinees. The test items should be easy to read and understand. The table revealed that both mathematics instructors/professors and pre-service teachers strongly agree that the MPT possesses good and appropriate mechanical make-up as shown by the mean rating of 4.91 and 4.66, respectively. An average mean rating of 4.79 of the two groups of respondents signifies that the MPT is outstandingly valid in terms of mechanical make-up which means that the MPT is readable and free from erasures and typographical errors.

The characteristics that test results be provided in a specific period of time that would give an immediate feedback for learners improvements is part of scoring. The table revealed that the mathematics instructors/professors strongly agree (4.91) while the pre-service teachers agree (4.37) that MPT possess good scoring characteristics. These results show that the MPT satisfied the need of the instructors/professors more than the pre-service teachers in terms of scoring characteristics. Though, the MPT is purely a multiple choice type of test which is easy to check and score but the students need an immediate feedback about their proficiency including their strengths and weaknesses in the set standards. This could be done only through an automated format MPT which is the gap of the study. Moreover, the average mean rating of 4.64 of the two groups of respondents revealed that the scoring characteristics are outstandingly valid.

The over-all assessment on the face validity of the MPT was *outstandingly valid* as revealed by the over-all mean rating of 4.72 supported by the strong agreement of the mathematics instructors/professors and pre-service teachers. This signifies that the MPT attained the standard characteristics of a valid assessment tool.

Table 1. Face Validity of the Mathematics Proficiency Test

Characteristics	Mathematics Instructors/ Professors		Pre-service Teachers		Ave. $\bar{X}$	Face Validity
	$\bar{X}$	Description	$\bar{X}$	Description		
1. Directions	4.89	Strongly Agree	4.59	Strongly Agree	4.74	Outstandingly Valid
2. Test Content	4.97	Strongly Agree	4.47	Agree	4.72	Outstandingly Valid
3. Mechanical Make-up	4.91	Strongly Agree	4.66	Strongly Agree	4.79	Outstandingly Valid
4. Scoring	4.91	Strongly Agree	4.37	Agree	4.64	Outstandingly Valid
<b>Average Mean</b>	<b>4.92</b>	<b>Strongly Agree</b>	<b>4.52</b>	<b>Strongly Agree</b>	<b>4.72</b>	<b>Outstandingly Valid</b>

**Practicality and Efficiency of the NCBS-Based Mathematics Proficiency Test**

One of the qualities of a good measuring instrument is the degree to which the measuring instrument can be satisfactorily used by teachers, researchers, supervisors, and students without requiring too much time, money and effort. That the exam should be implementable is called practicality and efficiency. Table 2 presents the average mean rating given by the mathematics instructors/professors and pre-service teachers on the practicality and efficiency of the Mathematics Proficiency Test (MPT) as an assessment tool.

It is reflected in the table that the mathematics instructors/professors and the pre-service teachers rated the MPT as *outstanding* in 8 out of 10 indicators of practicality and efficiency in this study.

This excludes the number 1 and number 5 indicators which support the previously stated claim of this study that the developed MPT may be further improved and repackaged as an automated test, which can provide an in-depth analysis and feedback on misconceptions and common errors committed by the pre-service teachers in general mathematics in just a short period of time for specific purposes.

The purpose of assessment is to gather reliable information for teachers to make informed judgments about the progress of students against specific task criteria and achievement against common standards (<http://vels.vcaa.vic.edu.au>). Hence it is necessary for every learning institution particularly the tertiary education to have their own system of assessment with its specific purpose relevant to the needs of the clientele.

*Table 2. Practicality and Efficiency of the Mathematics Proficiency Test*

INDICATORS	Pre-service Teacher		Mathematics Professor		Ave. $\bar{X}$	Practicality and Efficiency
	$\bar{X}$	Description	$\bar{X}$	Description		
1. The MPT has the ability to provide the result in just a short period of time.	4.24	Agree	4.71	Strongly Agree	4.48	Very Satisfactory
2. The material efficiently identifies the strengths of the examinees in general education mathematics.	4.66	Strongly Agree	4.57	Strongly Agree	4.62	Outstanding
3. The material efficiently identifies the areas that need further improvement in general education mathematics.	4.85	Strongly Agree	4.71	Strongly Agree	4.78	Outstanding
4. The MPT provides pre- service teachers' awareness on their own learning pace.	4.61	Strongly Agree	4.43	Agree	4.52	Outstanding
5. The MPT provides feedback on the misconceptions and common errors committed by the pre-service teachers in general mathematics.	4.46	Agree	4.43	Agree	4.45	Very Satisfactory
6. The over-all appearance of the MPT motivates the learner to work on it in order to pass the test.	4.56	Strongly Agree	4.71	Strongly Agree	4.64	Outstanding
7. The MPT is easy to administer and is implementable.	4.24	Agree	4.86	Strongly Agree	4.55	Outstanding
8. The material could be improved further and be used in the future.	4.61	Strongly Agree	5.00	Strongly Agree	4.81	Outstanding
9. The MPT helps prospective teachers prepare for teaching Mathematics in the field.	4.73	Strongly Agree	4.71	Strongly Agree	4.72	Outstanding
10. The MPT helps pre-service teachers prepare for the licensure Examinations.	4.83	Strongly Agree	4.57	Strongly Agree	4.70	Outstanding
<b>Average Mean</b>	<b>4.58</b>	<b>Strongly Agree</b>	<b>4.67</b>	<b>Strongly Agree</b>	<b>4.63</b>	<b>Outstanding</b>

**Difference in the evaluation of the two groups of respondents on the face validity and practicality and efficiency of the MPT**

Table 3 presents the difference in the perceptions of the mathematics instructors/professors and the pre-service teachers on the face validity and practicality and efficiency of the MPT as an assessment tool. It could be inferred from the table that the two groups of respondents significantly differ in their perceptions in terms of the MPT directions, test content and scoring characteristics with a computed t-value of 2.119, 2.964, and 3.907, respectively, which all lead to the rejection of null hypothesis ( $H_0$ ) at 0.05 level of significance ( $p < 0.05$ ).

These results show that the mathematics instructors/professors and the pre-service teachers differ in their needs assessment in terms of test directions, test content, and scoring characteristics of MPT as shown by their respective mean ratings. It is because the instructor/professors serve as proctor or examiner while the students are the one taking the test or the examinees. This truly explains why they significantly differ in their evaluation in terms of test directions, test content, and scoring characteristics of the MPT. This suggests that test developers must consider the needs of both the examiner and examinees in every aspect of the test administration which affect the flow and expected results of the conduct of the test.

On the other hand, the two groups of respondents do not differ significantly in their evaluations as to the mechanical make-up and the practicality and efficiency of the MPT as an assessment tool. These could be supported by the

computed t-value of 1.767 and 0.734, respectively, which failed to reject the null hypothesis ( $H_0$ ) at 0.05 level of significance ( $p > 0.05$ ). This means that the MPT satisfies both the need of instructors/professors and pre-service teachers in terms of mechanical make-up and practicality and efficiency of the MPT.

This supports the claim of the study that the developed MPT can serve its purpose of assessing the proficiency, including the strengths and areas that need further improvement in general education mathematics since it appears appropriate and can be practically and efficiently utilized as perceived positively by both groups of respondents. Any achievement test must possess certain practical qualities if it has to meet the criteria of a good evaluation and measuring tool. Rico (2011) states that aside from validity and reliability, a very good evaluation instrument should be applicable in a particular educational setting and teachers should not experience difficulty in the conduct and interpretation of test results. The evaluation procedures will succeed only if the teachers will find assessment and evaluation practical and efficient.

**The General Comments and Suggestions of the Respondents**

Comments from the two groups of respondents summarized as follows: (1.) Include in the general directions the number of hours required in taking the test, (2.) Arrange the numeral choices in ascending or descending order for all the items, (3.) There are items in the MPT that need to be rephrased or add information in the given problem, (4.) Problems reflect real classroom situations, and (5.) In general, the developed test is a very good assessment tool.

*Table 3. Difference in the Perceptions of the Two Groups of Respondents on the Face Validity and Practicality and Efficiency of the MPT*

INDICATORS	Means		t-value	p-value	Decision on $H_0$ ( $\alpha = 0.05$ )
	Pre-service Teachers	Mathematics Professors			
<b>I. Face Validity</b>					
A. Directions	4.59	4.89	2.119	0.039	Reject
B. Test Content	4.47	4.97	2.964	0.005	Reject
C. Mechanical Make-up	4.66	4.91	1.767	0.084	Do not reject
D. Scoring	4.37	4.91	3.907	0.000	Reject
<b>II. Practicality and Efficiency</b>	4.58	4.67	0.734	0.466	Do not Reject

## Conclusions

Based from the findings of this study, the following are concluded: (1.) The directions, test content, mechanical make-up, and scoring characteristics of the MPT are outstandingly valid, (2.) The MPT can be utilized efficiently for its practical purpose as an assessment tool, (3.) The pre-service teachers and the mathematics instructors/professors do not differ significantly in their evaluations as to the mechanical make-up and practicality and efficiency of the MPT, (4.) The respondents provided suggestions to further improve the MPT.

## Recommendations

The following are the recommendations: (1.) The NCBTS-Based MPT may be utilized as an assessment tool to diagnose the pre-service teachers' strength and weaknesses in general education mathematics, (2.) The MPT must be further improved and repackaged (e.g. automated MPT) as an institutional assessment device for future professional teachers, (3.) The pre-service teachers and the mathematics instructors/professors should always collaborate in terms of curricular innovations and development that answers the clients' needs, (4.) Suggestions made for the improvement of the MPT should be incorporated in the final packaging and in the future development and innovations.

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