Future Academy®'s Multidisciplinary Conference

The Development of diagnostic test using the attribute hierarchy method

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Abstract

Nowadays, to investigate students' potentiality, any exam has to contain a lot of questions. Therefore, using attribution hierarchy model will be able to reduce the number of questions. This study addresses the following research question: Which attributes are needed to be included in the diagnostic test and How much is the level of quality of the diagnostic test? The purpose of this study was to develop a diagnostic test and to quantify its quality. The study will concentrate in students' mathematical problem-solving skill. Moreover, the created diagnostic test will limit to the skill of solving adding and subtracting fractions questions only. The diagnostic test will be developed based on the attribute hierarchy model. To quantify the level of ability of students, the Bayes' Theorem was employed to determine the diagnostic score. Moreover, to quantifying the quality of the diagnostic test, 2-parameter item response model, content validity, Hoyt's reliability, and inter-rater reliability are used. The diagnostic test contained only 17 questions which are relatively low comparing to the current test. It is found that the difficulty parameter is between -2.14 and 1.06, the item discrimination parameter is 0.77 – 3.07, the content validity is 1.00, Hoyt's reliability is 0.84 and the inter-rater reliability is 0.90.

Keywords: Diagnostic test; Attribute hierarchy method

1. Introduction

Problem solving is the main objective of mathematics study. (National Council Teachers of Mathematics, 2012) Solving problems requires various skills including reading, keyword interpretation, and calculation skills in order to

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acquire the correct answer. It is imperative that students possess all of these skills. Absence of any of the skills means inability to solve mathematical problems. (Adam et al, 1977)

The results of O-NET, which evaluated students' achievements in mathematics and Thai subjects among Grade 6 students nationwide during academic year 2007-2010, show that the majority of the students achieved less than 50 marks in both subjects. (NIETS, 2012) This suggests that most Thai students lack reading, interpretation, and calculation skills, thus causing difficulties in solving mathematics problems. A part where students seriously lack understanding concerns fraction, which involves complex calculation that is hard to understand, especially adding and subtracting fraction. (Thipkhong, Siriporn, 2001; Phumee, Chelermsak, 1995) Therefore, teachers should have an instrument to diagnose their students' errors to be able to improve or adjust their lessons according to their students.

Nowadays, most concepts about students' error diagnosis are based on attributes for each lesson. For example, diagnosis of errors in decimal problems can be divided into attributes as follows: reading, interpretation, adding fractions, subtracting fractions attributes, etc. This method allows teachers to acknowledge their students' weaknesses among these attributes. This idea also suggest that tests have fewer questions, but capable of assessing every attribute. This method is called the Attribute Hierarchy Method (AHM), developed by Leighton and Gierl in 2004. Thus, this study aims to develop a diagnostic test for difficulties in solving mathematical problems regarding adding and subtracting fractions among elementary students, utilizing the Attribute Hierarchy Method.

2. Research Question

What are the characteristics and how good is the quality of the diagnostic test for mathematic problem solving skills regarding adding and subtracting fractions among Grade 6 students?

3. Purpose of the Study

To develop and evaluate the quality of the diagnostic test for diagnostic test for mathematic problem solving skills regarding adding and subtracting fractions Grade 6 students.

4. Attribute Hierarchy Method

Attribute Hierarchy Method (AHM) links the knowledge required to solve a certain type of problems with a student's mindset, displayed in forms of limiting the number of problems, attribute blueprint or cognitive specifications, and examinee response pattern. AHM focuses on creating an attribute hierarchy model which is used to develop the diagnostic test. (Leighton, Gierl & Hunka, 2004; Gierl, 2007; Gierl, Cui, & Zhou, 2009; Roberts, & Gierl, 2010; Wang & Gierl, 2011)

Diagnosis with the AHM includes keywords as follows:

- An attribute is the knowledge required in order to solve mathematical problems regarding a certain matter, hereinafter called 'A';

- Attribute hierarchy is the order of knowledge used in solving mathematical problems regarding a certain matter, starting from the fundamental attributes to more advanced attributes. For example, the hierarchy attribute of solving mathematical problems regarding subtracting includes problem reading skill (A1), interpretation of keywords in the problem which indicates subtracting (A2), and subtracting skill (A3).

5. Attributes required for solving mathematical problems regarding adding and subtracting fractions

Attributes required for solving mathematical problems regarding adding and subtracting fractions contains 8 attributes, listed in order from the most fundamental to more advanced ones as follows :

- Attribute 1: Understanding in reading fraction problems, being able to separate information provided from what the problem asks (A1) ;