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Causal complexities to evaluate the effectiveness of remedial instruction

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ABSTRACT

This study investigates 3 models of remedial instruction, e-learning, blended learning, and traditional instruction, to vocational high school students with low mathematics achievement to analyze whether student achievement improves significantly and how each instruction model facilitates improvement. This study applies partial least squares (PLS) and fuzzy set/Qualitative Comparative Analysis (fsQCA) to analyze the effectiveness and causal complexities of the 3 models. The results indicate that all 3 models facilitate substantial academic progress, the e-learning model being the most effective. The combinations of 6 negative antecedents cause the learning problems of the students. After the changes of a few of these antecedents through the use of remedial instruction, the students improve their scores. FsQCA provides antecedent combinations to show the causal complexities; hence, provides more accurate explanations than does the PLS.

1. Introduction

Teaching and training become increasingly critical in the knowledge economy. For example, Woodside (2012) suggests developing an accurate and useful incompetency training theory, which includes efficacious remedies. Wu (2010) investigates the factors of mathematics remedial instruction that affect underachieving junior high school students. Chiu (2009) develops a computer system to facilitate remedial geography instruction for junior high school students. Yang, Lai, Yao, and Huang (2014) investigate the effect remedial instruction exerts on students with low socioeconomic status and on the mathematics competence, interest, and confidence of underachieving students.

Woodside (2013) suggests moving beyond the logic of multiple regression analysis (MRA) by using algorithms to build and test theories for two reasons. First, MRA formulates relationships for symmetric data; however, problems may not always include symmetric data. Second, MRA yields net effects. Because the effectiveness of remedial instruction may involve various combinations of factors, this study conducts and compares analyses by using partial least squares (PLS) and fuzzy set/Qualitative Comparative Analysis (fsQCA).

This study compares 3 models of instruction: e-learning, blended learning, and traditional instruction. Students take the tests before and after receiving remedial instruction, and the differences between their two scores indicate which instruction model is the most effective. In addition, this study explores the changes in student motivation and attitude. FsQCA is suitable for illustrating the combinations of factors and demonstrating the student changes before and after the remedial instruction.

2. Literature review

Regardless of models of remedial instruction, close teacher involvement, time, and place affect the instruction outcome. Remedial instruction mainly enables students who did not achieve the instruction target or who have learning difficulties to relearn. The theoretical structure in this study builds on concept of remedial instruction to discuss whether the various instruction models can impose on students as independent antecedents. Students follow different learning paths, and their scores determine which model facilitates improvement or produces differences in learning motivation and attitude.

2.1. Blended learning

E-learning, using science and technology to enable students to learn without time and space limitations, is applicable using smart phones, tablet PCs, the Internet, computers, videos, DVDs, and television. Thus, e-learning is applicable to network learning, computer learning, and virtual classrooms.

According to Valiathan (2002), blended learning refers to a combination of education and training methods that use cooperative learning software, online courses, electronic performance support systems, and knowledge management tools to integrate different events. In addition, Rossett (2002) proposes that blended learning stretches beyond the e-learning and traditional learning methods, combining two or more learning styles or media tools, such as formal and informal learning, face-to-face courses, online experience sharing, direct guidance or self-management, and digital document references. Singh (2003) suggests

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that blended learning mixes a variety of learning models, such as traditional face-to-face instruction, synchronous online learning, and online self-learning.

Ward and LaBranche (2003) determine that blended learning combines the advantages of science and technology through e-learning and teacher and student participation through traditional learning. By utilizing face-to-face and e-learning, teachers can strengthen and extend the learning efforts of the learner. Irons, Keel, and Bielema (2002) explore the impact of network instruction system use location and frequency on student satisfaction in a blended learning environment, discovering that the more frequently students use the network instruction system, the higher is their satisfaction.

Boyle, Bradley, Chalk, Jones, and Pickard (2003) assert that a blended learning environment can improve the success rate of students in learning how to program. To create an effective learning experience, Aspden and Helm (2004) explore how traditional-learning students in a blended learning environment connect with students engaged in online learning. Terashima, Ikai, Yoshida, Kamei, and Kubota (2004) conduct a study on multimedia curricula, determining that blended learning can foster an enterprising spirit that enhances learning in students. Trippe (2004) uses the scores to compare the learning effectiveness of asynchronous online-learning students and traditional-learning students. Dziuban, Hartman, and Moskal (2004) compare the students engaging in traditional classroom learning, blended learning, and online learning, proposing that a blended learning environment improves student learning effectiveness and reduces dropout rates.

In the present study, blended learning refers to initial traditional instruction that is then blended with e-learning. Because a considerable number of vocational high school students are failing at math, teacher and time resources are necessary to conduct remedial instruction. When comprehensive remedial curricula for students with low mathematical achievement are taught, appropriately introducing digital and traditional instruction, students who despair of learning mathematics can regain confidence and catch up to normal course progress.

2.2. Learning motivation and attitude

Learning is the experience or practice that produces long-lasting change in the knowledge or behavior of a person. Mathematics teachers should be able to improve student mathematics performance and the effectiveness of instruction if they can stimulate or create student motivation to learn mathematics during the instruction process.

Raffini (1996) believes that to arouse the intrinsic motivation to learn, a teacher first needs to understand the five demands of students: autonomy, competence, sense of attribution, self-esteem, and happiness. Strong learning motivation and interest can enhance learning rates. When students have higher learning motivation, the effectiveness of learning will increase (McCombs, 2001).

Learning motivation is subject to intrinsic or extrinsic psychological impact and possibly results from interactions between personal subjective awareness and the external environment. Hence, this study integrates humanistic, cognitive, and social learning viewpoints to create experimental instruction and measure student learning motivation according to three factors: active learning strategy (ALS), mathematic learning value (MLV), and achievement goals (AG). The primary instruction goal is to stimulate student motivation, enabling students to achieve instruction objectives.

Mathematics is among the most difficult subjects for primary and secondary school students. Approximately 6% of junior high school students have severe learning disabilities in math (Fleischner & Marzola, 1988). Instructional method changes by mathematics teachers affect student motivation to learn mathematics; therefore, in addition to changing instruction strategies and designing appropriate learning activities for students, teachers should create a suitable learning environment for students. Remedial instruction mathematics teachers should focus on student differences, designing appropriate learning activities on the basis of the differences in instruction units. Hence, this study includes e-learning and blended learning models as the remedial mathematics instruction to enhance student learning motivation, which could subsequently enhance mathematics learning achievement.

Although Simonson, Smaldino, Albright, and Zvacek (2000) determine that four key indicators (attitude, experience, cognition, and learning style) can enhance the process of e-learning, they reveal that attitude is the most critical indicator. Student attitude affects learning.

Krech, Crutchfield, and Ballachy (1962) and Rosenberg and Hovland (1960) indicate that attitude is a complex psychological process consisting of the following three components: the cognitive component, which refers to the perceived beliefs and knowledge of the attitude object; the affective component, which is the positive or negative feelings toward the attitude object; and the behavioral component, which involves the action tendencies toward the attitude object. Shrigley (1990) believes that attitude is the state of preparation before a reaction. Attitude relates to cognition and interacts with behavior.

According to Fennema and Sherman (1976), mathematics attitude comprises the comprehensive performance of confidence and success when studying mathematics; parent and teacher attitudes toward mathematics; the perception that mathematics is a subject only men are good at; and the usefulness, exploration, motivation, and anxiety of studying mathematics. Similarly, Sriampai (1992) suggests the mathematics attitude includes the comprehensive performance of confidence in mathematics, teacher attitudes toward mathematics, attitude toward the success of learning mathematics, and usefulness of mathematics.

This study defines the attitude toward mathematics learning as follows: After learners accept mathematics learning activities, the three factors of self-awareness (SA), learning method (LM), and learning plan (LP) generated in response to mathematics should measure student learning attitude. Mathematics learning attitudes vary, and their formation is inseparable with the learning environment. Therefore, teachers should use effective instruction strategies, create interesting instruction activities, and encourage positive attitudes toward mathematics to inspire learning motivation and long-term, sustainable interest in mathematics.

On the basis of the above literature, this study analyzes the effectiveness of three remedial instruction models, including e-learning, blended-learning, and traditional-instruction, and proposes the following propositions:

P1. *Three different remedial mathematics instruction models have significant difference between the average progresses in mathematics achievement test scores.*

P2. *Three different mathematics remedial instruction modes have significant difference in attitudes before and after each test for mathematics learning and mathematics learning attitude.*

P3. *Three different mathematics remedial instruction modes have significant difference in motivation before and after each test for mathematics learning and mathematics learning attitude.*

3. Research methodology

3.1. Study respondents

This study chooses a vocational high school in Hsinchu City, Taiwan. Respondents are the students who failed the semester math exam. Scores from examination results before and after six weeks of remedial instruction are for analysis to explore the differences in mathematical learning motivation and attitude.

Three groups of students are under study as e-learning students, blended-learning students, and traditional-instruction students. The study explores the effectiveness of remedial instruction and learning among the different instruction models. This study expects to collect 94 valid samples.