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# Preparing English as a Second Language Students for College Level Math

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## Acknowledgement

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## Introduction

In a diverse classroom, there are students who are in need of both mathematics and English as a second language instruction. One of the challenges faced at Lake Washington Institute of Technology (LWIT) was the development of a pathway for English language learners into core academic courses at the college. In addition, English language learners were faced with difficulty in understanding the vocabulary terminology in a typical mathematics course. Because of these two critical issues, the Bill and Melinda Gates Foundation provided a research grant for an Integrated Basic Education Skills Training (I-BEST) On-Ramp Math Program at LWIT. As research has shown high failure rates for both ESL and non-ESL students enrolled in developmental mathematics (Bailey, 2009; Boylan, 2011; Howard & Whitaker, 2011), another reason for this program was to help improve the success rates of such ESL students.

The primary focus of the study was to prepare ESL (English as a Second Language) students at CASAS levels II and III (levels II and III are low level English speaking students that have learned basic phrases and sentences in English) for a successful pathway to college level mathematics based on Washington State CASAS testing for college level mathematics. Two primary research questions were focused on:

1. What impact does the development of an On-Ramp Math Program have on ESL students at LWIT in relation to their pretest and posttest scores for CASAS Math testing?

2. What approaches to pedagogical teaching and learning can be identified in the On-Ramp Math Program for future ESL students learning mathematics at a community college?

The On-Ramp Math Program was a pathway-learning model for ESL students to learn both English and mathematics at the same time via a developmental mathematics course. The program was a five-credit pre-algebra course that met twice a week, and was based on I-BEST. It had two instructors: a content (mathematics) instructor and a language instructor.

## Method

The main study variables included the CASAS pretest and posttest. The sample of the study included the 18 students in the On-Ramp program who were randomly selected from CASAS levels II and III student population. Although this is a small sample size, the focal point in the study was on developing curriculum and pedagogical approaches to be used in future research for ESL students learning English and mathematics. Data was collected over an eleven week period in the Fall 2012 quarter by the LWIT Academic Skills Center staff. A paired samples *t*-test was used for analysis since the same participants took both tests.

Of primary importance in the development of the ESL On-Ramp Math Program was the integration of teaching methodologies that proved effective in an ESL environment. For example, the use of contextualized mathematics material and applied mathematics to everyday settings proved to be an effective teaching methodology (Valenzuela, 2012). Another example was the use of common everyday concepts which students were familiar with: for example, daily activities such as going to a bank and going grocery shopping. By developing mathematical worksheets and exercises around these common familiar themes, students were able to better grasp the English vocabulary and mathematical concepts.

To further gauge students' understanding and learning of English and mathematics, level descriptors were used with the pretest and posttest scores. Skill level descriptors ranged from

low level English and mathematics understanding (i.e., level A) to high functioning levels and knowledge of English and math (i.e., level E).

As the On-Ramp Math Program is centered on the IBEST classroom in which there is an overlap of instructional learning for both English and mathematics, there was a mathematics instructor who focused on the mathematics portion of the

class, and a language instructor who had a 50% overlap of instruction. The language instructor, trained in ESL teaching methodologies, worked with students on language literacy.

## Results

The results of the paired sample *t*-test are as follows:

**Paired Samples Statistics**

		Mean	N	Standard Deviation	Standard Error Mean
Pair 1	Pretest	208.44	18	18.066	4.258
	Posttest	227.400	18	11.4388	2.6962

**Paired Samples Correlations**

		N	Correlation	Significance
Pair 1	Pretest & posttest	18	0.560	0.016

The mathematical CASAS pretest and posttest scores are indicators of a level range of 150 to 250, which demonstrate a student’s English literacy and mathematical understanding. Overall, results from the research indicated a mean CASAS pretest score of 208, which increased to a mean score of 227. The research, via the *t*-test results, showed the results were significant at  $p = 0.02 < 0.05$ . The increase from the pretest to the posttest indicated an increase in CASAS levels from beginning basic skills (level B) to advanced skill (level C) based on the CASAS skill level descriptors for Adult Basic Education (CASAS Test Administration Manual, 2013). In essence, the student moved from a level B of knowing simple phrases in English and basic mathematics to a higher functioning level C of more advanced conversational topics in English and comprehension of mathematics for employment. From a pass ratio standpoint, 67% of the students passed the On-Ramp Math Program. This is comparable to 65% of the general student population passing the same level of mathematics at LWIT.

## Discussion

Based on the results of the study, for the first research question, there was a significant effect and change in the pretest and posttest scores for the ESL students after they completed the On-Ramp Math Program. As discussed in the results of the *t*-test, the ESL students moved from level B to level C in

regards to the level descriptors for CASAS. Also, by focusing on instructional and learning strategies for ESL students when learning mathematics, vital pedagogical approaches were identified to address the second research question. These were an *overlap of instruction, vocabulary building, mathematics remediation, curriculum support, cultural understanding, and computer integration.*

## Overlap of Instruction

The use of two instructors in the same course was instrumental to the success of the program. Research has shown that the IBEST teaching model, where academic and developmental education are included in a student’s program pathway classes via an overlap of two instructors, has shown to be effective in helping students successfully complete their academic or developmental college work (Watchen et al., 2010).

## Vocabulary Building

A focus on the vocabulary of mathematical problems and contextualizing assignments was also helpful. Before each mathematics lesson, the ESL instructor provided visual handouts that correlated with the English vocabulary. This practice provided students additional language literacy support before working on mathematical problems in English. Furthermore, the mathematics instructor also focused on helping students understand the conceptual and mechanical aspects of doing contextualized mathematics problem in the class setting.

## Mathematics Remediation

Another effective teaching strategy for the ESL students was continual remediation. Remediation of pre-college mathematics has shown to be an effective tool to enhance mathematical skill deficiencies (Bahr, 2007; Bahr, 2008; Hoyt & Sorensen, 2001). Students in the On-Ramp Math Program came from culturally different backgrounds and spoke different dialects. Each of these students also had differing levels of mathematical understanding. Thus, one of the teaching methodologies employed was grouping stronger mathematics students with those who had deficiencies in their mathematics skills. This same methodology was utilized when pairing stronger English speakers with those who knew very little English. In essence, cooperative learning was used. This pedagogy yielded high student engagement with each other and the course materials (Millis & Panitz, 2010).

## Curriculum Support

ESL support for students focused on ensuring that they had materials and proper curriculum necessary to comprehend and recognize critical mathematics terms and vocabulary. Research has shown that mathematics modeled to authentic situations benefits English language learners (Vega & Travis, 2011). As noted by Vega and Travis (2011), “English language learners gain the vocabulary needed to improve understanding of concepts and students who seem to struggle the most with traditional approaches seem to do well in the reform type of environment” (p. 12).

In the development of curriculum material and the incorporation of contextualized teaching methodologies, it was clear that the focus on developing authentic situations was a critical aspect for the ESL students’ learning of mathematics. As an example, one particular worksheet which was developed showed the floor plan of a new home. The floor plan included the dimensions of each room. It was the student’s responsibility to calculate the square footage of each room, and the total square footage of the home for the home to be re-carpeted. Incorporated in this exercise was the English vocabulary for square footage at the beginning of the exercise.

The curriculum content was also aligned with a pre-algebra course. Much of the emphasis was on developing authentic situations and problems for the ESL students to work on in relation to pre-algebra level problems. The ESL instructor developed mathematics problem vocabulary handouts to assist with vocabulary definition and pronunciation practice. Mathematics vocabulary worksheets from an online website were also used (El Civics, 2012). Further ESL support included a common measures handout and helpful vocabulary translations from *Helping With Math* (2012). It is vital to remember that ESL students require easy-to-understand materials, which also

incorporate a visual image of mathematical processes. These can include function tables or numerical visualizations of solving algebraic problems in context. Furthermore, the concept of using environmental print (visual images) as a basis for allowing students to engage with their environment and correlate language and words with it was an effective teaching practice for language learners (Christie, Enz, & Vukelich, 2011).

## Cultural Understanding

As part of the On-Ramp Math Program, specific cultural aspects were also emphasized with students. For instance, during a lesson on calculating hourly pay, expectations were reviewed in terms of both hourly wages and the calculation of overtime pay in the United States. Also, the cultural expectations of college were emphasized in relation to college course expectations, and as part of this exercise, students and instructor reviewed the student outcomes of higher-level mathematics course syllabus. Some students, who were already working in the United States, had the opportunity to share how they utilize mathematics in their work settings.

## Computer Integration

The use of computer-integrated learning in the On-Ramp Math Program proved to be a successful teaching methodology in relation to how ESL students learned mathematics and English. There is evidence showing that computer-integrated mathematics courses are proving effective with developmental college mathematics students (Spradlin & Ackerman, 2010). For ESL students, the interaction with the computer aided them with the visual aspects of language-learning and the ability to manipulate mathematics through the computer-learning platform. One of the tools utilized was MyLabsPlus, a Pearson product, which incorporated a standard pre-algebra platform in a mastery-based learning system.

## Conclusion

The focus on developing applied mathematics material that students could relate to in everyday life was helpful for students in the ESL On-Ramp Math Program. Consistently reinforcing vocabulary in context aided ESL students in learning mathematical vocabulary in real life situations. Furthermore, when students worked in cooperative groups, they were eager to help each other both in learning English and mathematics. The visual aspect of learning, both with visual aids and computer-integrated learning, proved to be an effective pedagogical approach for students learning both English and mathematics in the same class. Moreover, it was helpful to emphasize work-place culture, cultural expectations at college, and expectations at the workplace to both aid students in the appreciation of the different cultures at work in and out of school. All these were helpful to prepare students for the

workplace in the United States. ESL students are familiar with working in collaborative environments, and students were encouraged to talk about and share their cultural differences in relation to how they learned mathematics in their own country.

It was evident in this study that further research in the area of developing both language-learning and mathematics is needed. The research study was only over an eleven week period. To gain a further understanding of ESL and mathematics learning strategies, multiple reviews over at least a year would help in evaluating the strategies gained during this study. With the diversity of the classrooms and diversity of learning at the community college level, having a broader comprehension of pedagogical approaches to both language learning and mathematics will help students on a pathway towards achieving their college level coursework.

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