Appendix B

ALEKS Survey

Name:_________________________

Teacher:_______________________

4 strongly agree, 3 agree, 2 disagree, 1 strongly disagree

1. I feel that ALEKS has made me better at mathematics.
   4 3 2 1
2. I enjoy working on math problems in ALEKS.
   4 3 2 1
3. I can calculate story problems better on ALEKS than Saxon
   4 3 2 1
4. I can calculate fractions better on ALEKS than Saxon
   4 3 2 1
5. I can calculate problems that use money better on ALEKS than Saxon.
   4 3 2 1
6. I can use decimals more effectively on ALEKS than Saxon
   4 3 2 1
7. I can perform math problems more effectively on ALEKS than Saxon.
   4 3 2 1
8. I can use division more effectively on ALEKS than Saxon.
   4 3 2 1
9. I can use multiplication more effectively on ALEKS than Saxon.
   4 3 2 1
10. I feel that I can use mathematics in life effectively because of the ALEKS program. 4 3 2 1

Appendix A

Heritage University Special Project Permission to Conduct Research

Permission has been given for Richard Nordlander by Marla Veliz. to conduct an action research project as part of the Heritage University Masters Degree Program entitled An Analysis of the Implementation of Assessment and Learning in Knowledge Spaces Mathematical Program. The Hypothesis of this study is the following:

Students who use the online math curriculum will experience significant growth in math grades when compared to the students who use the non-online curriculum. Students who use the online math curriculum will have a higher percentage of growth in math concepts when compared to the students who use the non-online curriculum. Students who participate in the online math program will report that their math skills have improved.

A copy of the project survey will be presented to Marla Veliz before being given. The results of the study will be shared with the Principal and other building departments as appropriate.

Signature

Marla Veliz

Marla Veliz

Date 6/20/2016

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Future research should include a more expansive placement test, more objective information from instructors, and gain consistent analytics throughout the year to determine the effectiveness of the program.

Conclusions

The ultimate conclusion that was reached by this research was that further research and analysis was necessary before the ALEKS program could be fully accepted. Similar studies saw an increase in student growth due to the use of knowledge space theory and technology, which wasn't supported in this research. With the consistency of information supportive of technology integration, ultimately the researcher must conclude that this study wasn't done for a long enough period of time and needing modifications to gain more objective and consistent data.

Recommendations

Based on the conclusion, a few recommendations can be offered. First, is that further research should be done to accurately assess the effectiveness of the ALEKS software in the school's setting. Second, while the grades did show a drop, the small but not significant increase in placement test scores suggest that ALEKS was not proven to be unsuccessful. So, the researcher recommends that the program is continued with data collected regularly to assess the ultimate impact of the program on the school's student population.

CHAPTER 5

Summary, Conclusions and Recommendations

Introduction

This chapter has been organized around the following topic: (a) introduction, (b) summary, (c) conclusions, (d) recommendations. The purpose and nature of the research Project and concern are paraphrased here.

Summary

This study covered the effectiveness of the ALEKS software in a school setting as a replacement for the Saxon incremental math curriculum. Previous studies suggested that knowledge space theory and technological approaches were effective at helping students to learn and grow in their skills. The research was done over a period of 3 quarters at New Horizon School. Data was gathered from student grades and placement tests before and after full ALEKS implementation. Ultimately, grades showed a significant decline, placement tests showed a limited increase, and students surveyed felt that ALEKS improved their mathematical skills.

The student population might also be a factor that was impacting the data. The large number of autistic and disabled students in the school will typically struggle with new changes and experiences and thus require more time than other groups to adjust to the material and the new delivery.

<u>Summary</u>

The research failed to reject the null hypothesis and thus couldn't accept the hypothesis. Students who transitioned to ALEKS saw a significant decrease in grades and didn't see a significant increase in placement score results. However, most students expressed that they felt their skills did improve as a result of the use of the ALEKS program.

This inconsistencies of information between the various analytics suggests that the study itself needed modification to accurately measure student growth. This study needed to be done for a longer period of time with different analytics collected in order to accurately measure and predict student growth as a result of the shift to the ALEKS programs.

When the students were shifted to ALEKS, the ALEKS system's grade was highly objective. Thus the calibration of the grades could have seriously impacted the grades. If the ALEKS software was more accurate, then the drop in grades wouldn't necessarily mean that students were performing poorly, but could instead be demonstrating that students were being accurately assessed unlike the prior system.

Thirdly, the placement tests used to determine the net growth in skills might have been a factor themselves. The placement test was the same with the same questions for both times. While they were given months apart, the questions were the same and so some improvement would have been expected as a result of increased familiarity with the test. In addition to this, the placement test had a limited selection of questions and for some students, the format of the questions themselves may have been a factor impacting the limited increase in scores.

From an English Language Learner's perspective, it would have been anticipated to have an increase due to ALEKS using more visuals and less culturally biased questions like there are in the Saxon system. However, the lack of significant increase doesn't confirm or deny the assertion that ALEKS is more linguistically friendly and instead demonstrates that further research is required.

wasn't sufficient to confirm the hypothesis that students using ALEKS would show significant improvement

Survey results demonstrated that students overall felt that ALEKS improved their mathematical skills, which would support the hypothesis. However, the grades showing a significant decrease combined with inconclusive placement test data demonstrated that this overall impression of the students didn't fit with the actual findings of the data.

Discussion

This study ultimately would seem to run contrary to the expectation of other similar studies. Similar studies supported that the use of Learning Space Theory programs should show a significant increase in scores and grades. There are several factors that could account for the results of this.

First of all, the implementation of ALEKS was done in a manner that may not have adequately prepared students for the adjustment to the new program. Multiple teachers approached and presented ALEKS differently to their students and this thus may be a factor in the low growth of math skills as measured on the placement test.

Secondly, the previous grading system was supposed to be objective, but it is possible the grades were handled in a highly subjective fashion by the teachers.

skills. Students also showed via the survey an increased confidence in their math skills as a result of the implementation of the ALEKS program. In this case, the null hypothesis was rejected and the hypothesis was supported.

The grades dropped significantly as a result of the implementation of the ALEKS program. This thus rejects the hypothesis which suggested that grades would improve as a result of the school's shift to the ALEKS software.

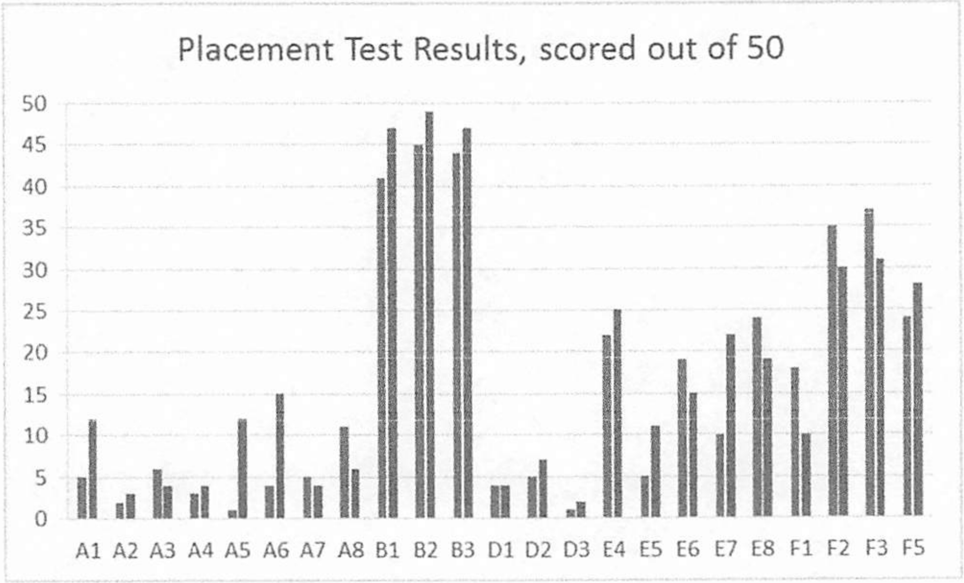

Figure B

The placement test results showed improvement but not enough to be considered statistically significant in light of the hypothesis. The 80% confidence level with the placement test data showed an improvement, but the improvement of freedom of 23. To show significance at P=0.05 a t-value of 2.069 was required with a degree of freedom of 23. The results of this study showed a t-value of 1.58 with a P=.20. Therefore the t-Test showed that the second portion of the null hypothesis could not be accepted and the hypothesis could not be supported.

The mean improvement score for Saxon was 3.40. The mean score for the Assessment and Learning in Knowledge Spaces (ALEKS) was -6.21.

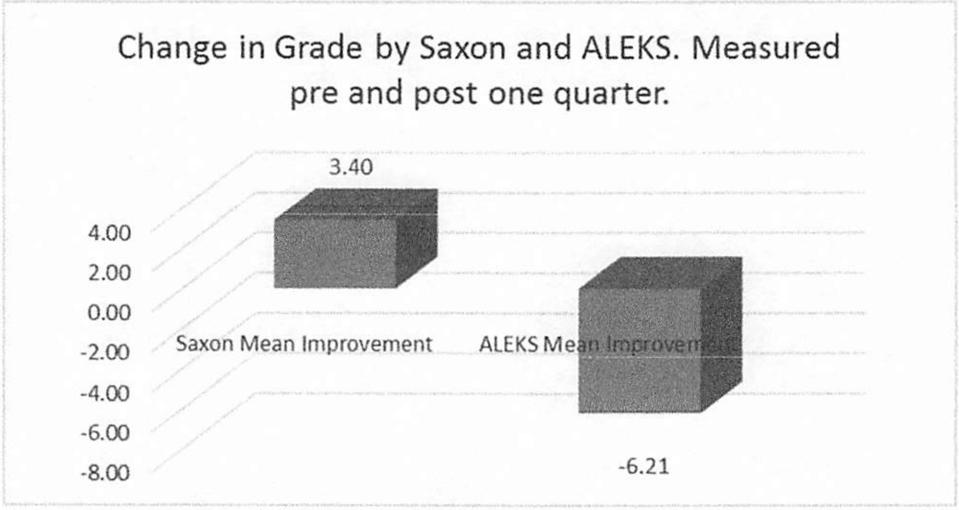

Figure A.

<u>Findings</u>

Given the analysis of the data and the testing of the null hypothesis or answering the research question, a limited number of findings became apparent. Students showed a significant drop in grades as a result of the transition to ALEKS but didn't show a statistically significant increase in their mathematical

Using the statistical calculator program Stat Pak, a statistical t-Test, was performed to determine whether there was significance at the P= .05 confidence level. To determine significance of the hypothesis: Students who use the online math curriculum will experience significant growth in math grades when compared to the students who use the non-online curriculum and students who use the online math curriculum will have a higher percentage of growth in math concepts when compared to the students who use the non-online curriculum., the researcher used a Dependent t-Test.

The results of the Dependent t-Test for math grades showed the number of change in grades for students was -2.87, the mean score was -9.26 while the number of scores for the students was 24 with a mean score of -6.21. The t-Value was -2.87 with a degrees of freedom of 23. To show significance at P=.05 a t-value of -2.069 was required with a degree of freedom of 23 The results of this study showed a t-value of -2.87 with a degrees of freedom of 23. Therefore the Dependent t-Test showed that the first portion of the null hypothesis could not be rejected and the hypothesis could not be supported.

The results of the Dependent t-Test for math skills as measured by the placement test was 1.40, the mean improvement in scores score was 1.58 while the number of scores for the students was 24. The t-Value was 1.58 with a degree

To the statement "I feel that I can use mathematics in life effectively because of the ALEKS" XV respondents strongly agreed to the statement while seven agreed. There were two respondents who disagreed to the statement and one student who strongly disagreed. The mean score was 3.44.

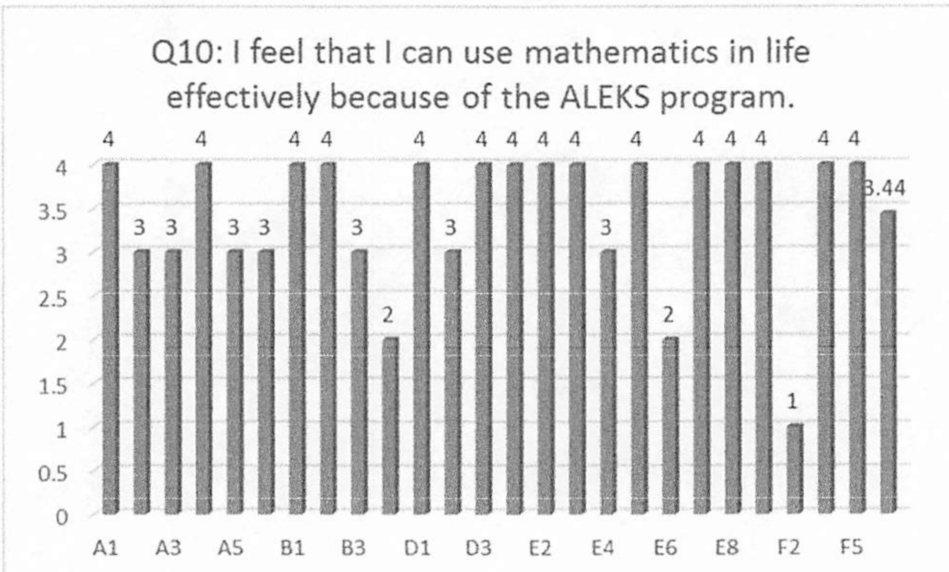

Figure 10

To the statement "I can use multiplication more effectively on ALEKS than Saxon." XVI respondents strongly agreed to the statement while six agreed. There were two respondents who disagreed to the statement and one student who strongly disagreed. The mean score was 3.48.

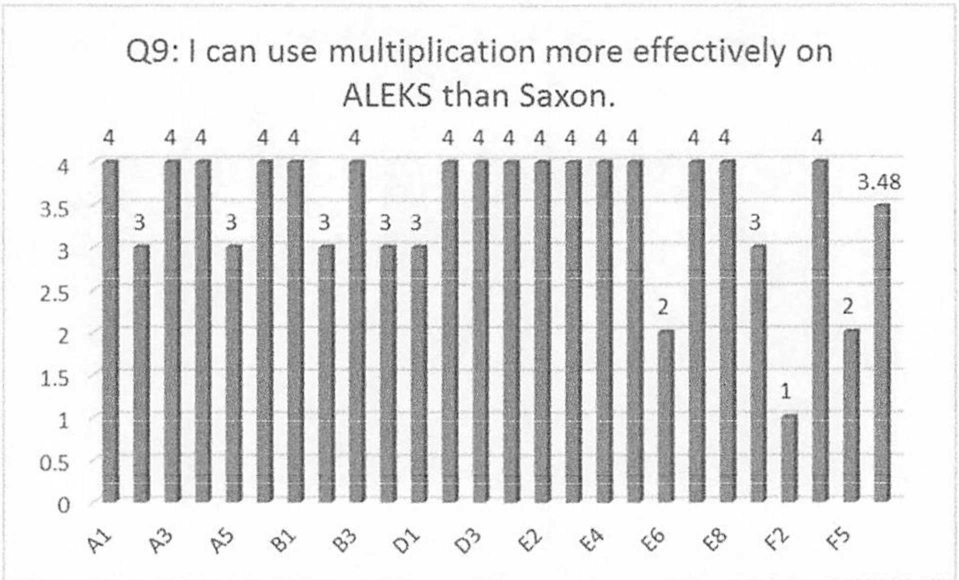

Figure 9

To the statement “I can use division more effectively on ALEKS than Saxon.” Six respondents strongly agreed to the statement while XIV agreed. There were three respondents who disagreed to the statement and two students who strongly disagreed. The mean score was 2.96.

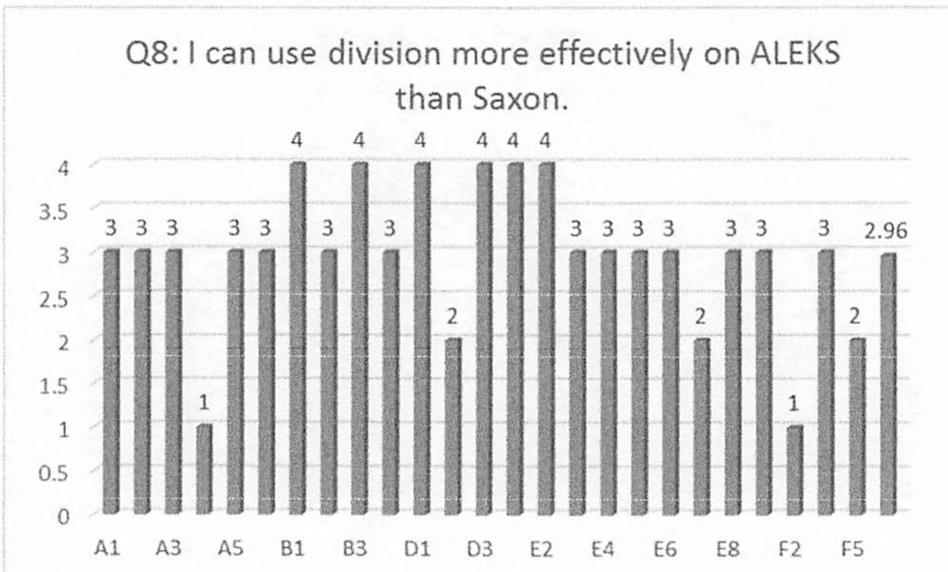

Figure 8

To the statement “I can perform math problems more effectively on ALEKS than Saxon.” XII respondents strongly agreed to the statement while ten agreed. There were two respondents who disagreed to the statement and one student who strongly disagreed. The mean score was 3.32.

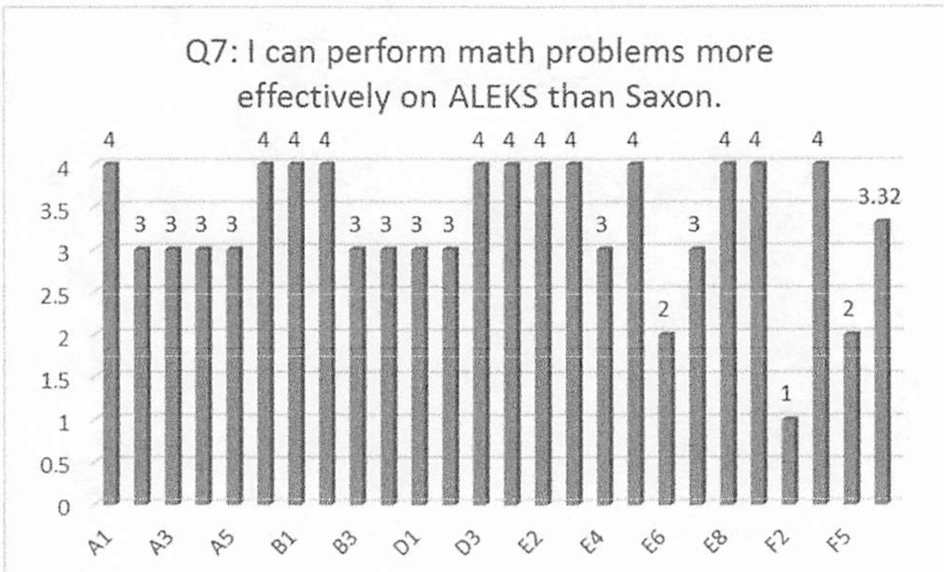

Figure 7

To the statement "I can use decimals more effectively on ALEKS than Saxon" Eight respondents strongly agreed to the statement while XIII agreed. There were three respondents who disagreed to the statement and one student who strongly disagreed. The mean score was 3.12.

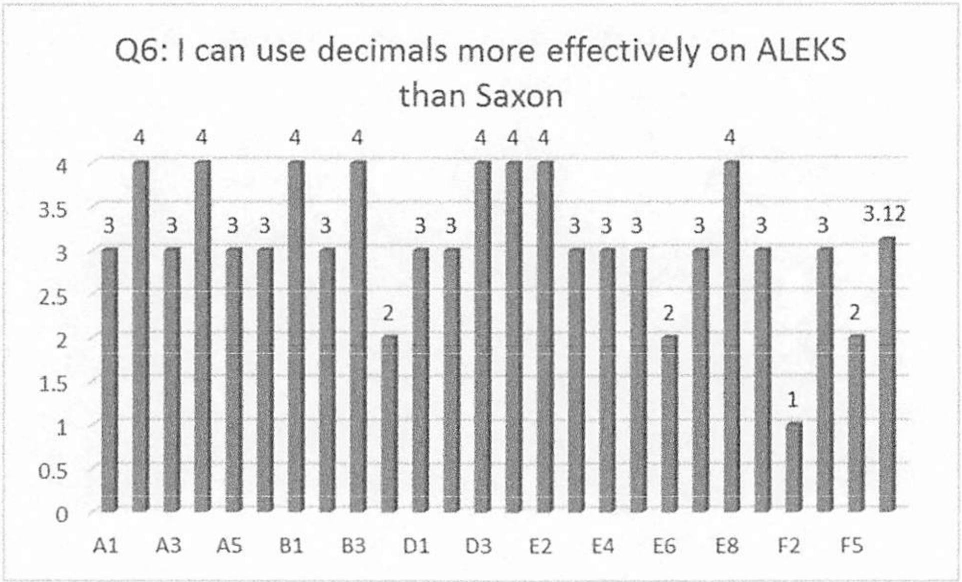

Figure 6

To the statement "I can calculate problems that use money better on ALEKS than Saxon." XIII respondents strongly agreed to the statement while nine agreed. There were two respondents who disagreed to the statement and one student who strongly disagreed. The mean score was 3.36.

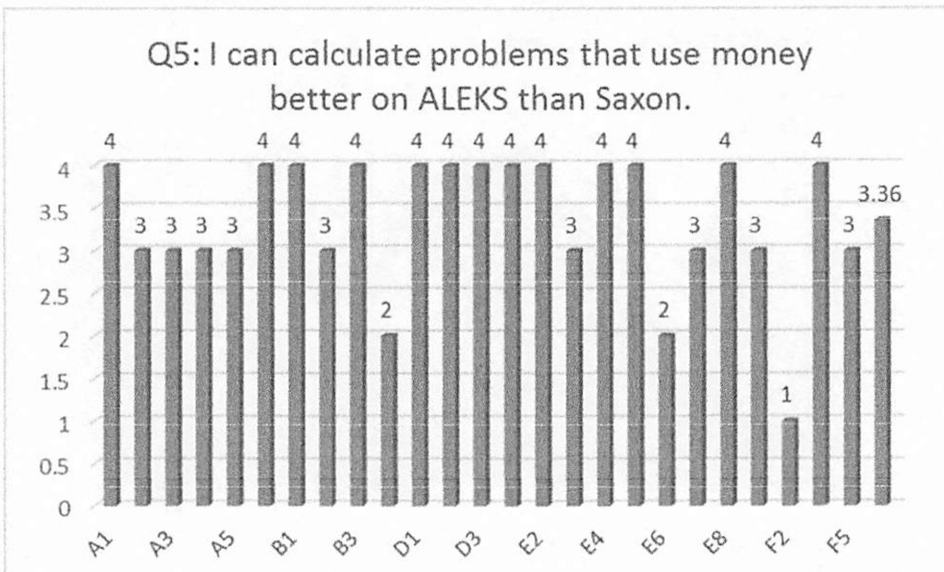

Figure 5

To the statement “I can calculate fractions better on ALEKS than Saxon” Nine respondents strongly agreed to the statement while nine agreed. There were five respondents who disagreed to the statement and two students who strongly disagreed. The mean score was 3.00.

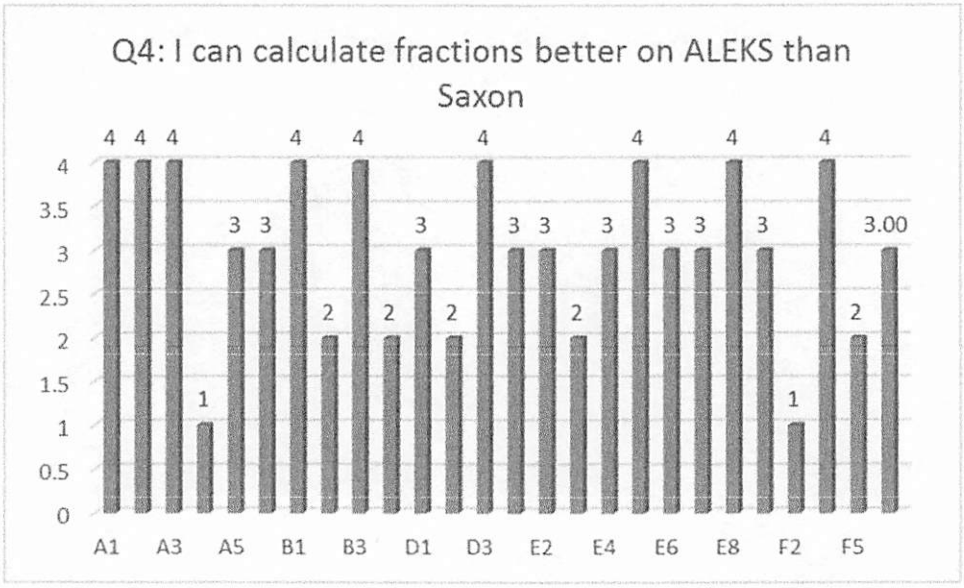

Figure 4

To the statement “I can calculate story problems better on ALEKS than Saxon” XII respondents strongly agreed to the statement while nine agreed. There were three respondents who disagreed to the statement and one student who strongly disagreed. The mean score was 3.28.

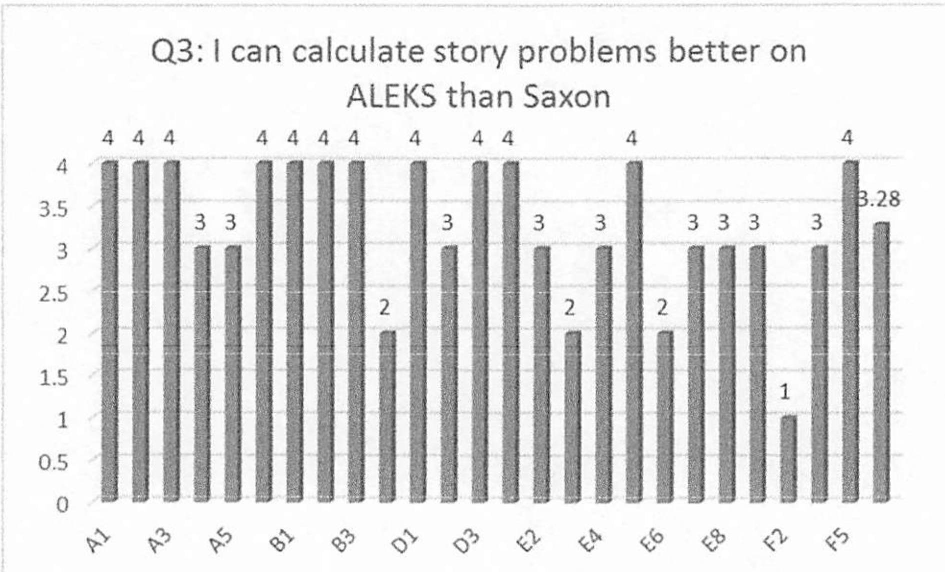

Figure 3

To the statement "I enjoy working on math problems in ALEKS" Seven respondents strongly agreed to the statement while XI agreed. There were four respondents who disagreed to the statement and three students who strongly disagreed. The mean score was 2.88.

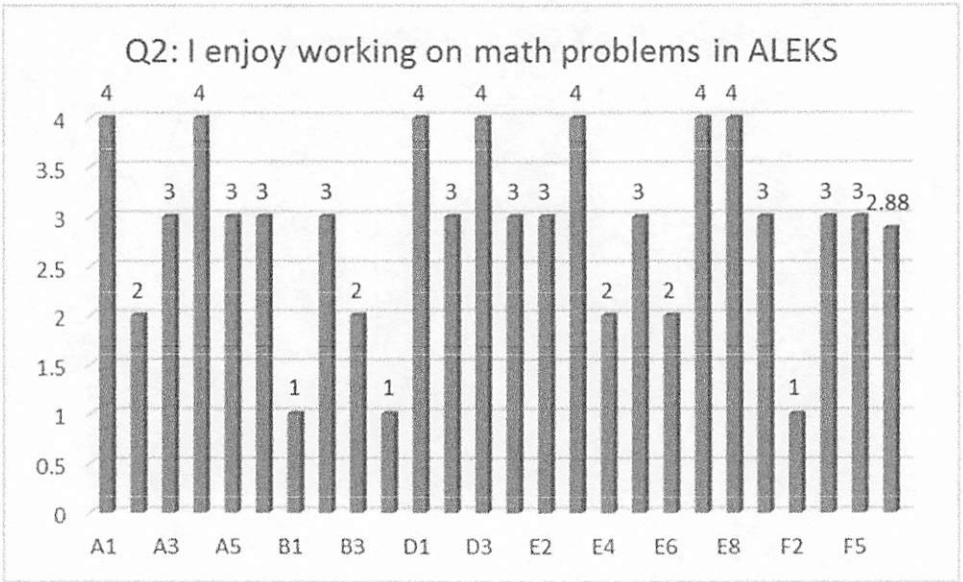

Figure 2

Results of the Study

A survey to answer the hypothesis "Students who participate in the online math program will report that their math skills have improved" was conducted. Graphs were developed to visually display the data.

To the statement "I feel that ALEKS has made me better at mathematics" XIII respondents strongly agreed to the statement while ten agreed. There was one respondents who disagreed to the statement and one students who strongly disagreed. The mean score was 3.40.

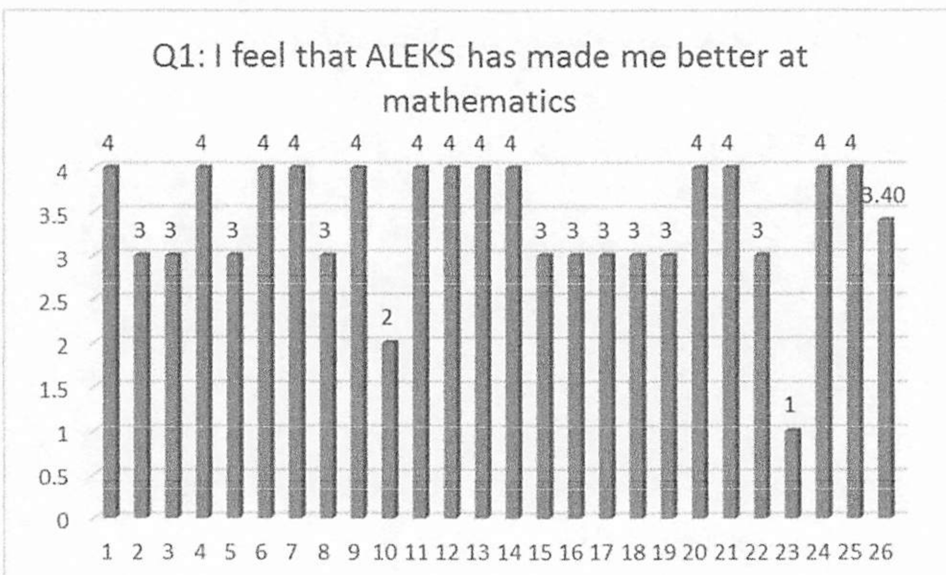

Figure 1

which 3 had their masters degree. However 100% of the teachers were highly qualified (office of Superintendent of Public Instruction).

Hypothesis

Students who use the online math curriculum will experience significant growth in math grades when compared to the students who use the non-online curriculum. Students who use the online math curriculum will have a higher percentage of growth in math concepts when compared to the students who use the non-online curriculum. Students who participate in the online math program will report that their math skills have improved.

Null Hypothesis

Students who use the online math curriculum will not experience significant growth in math skills when compared to the students who use the non-online curriculum. Students who use the online math curriculum will have a lower percentage of growth in math concepts when compared to the students who use the non-online curriculum. Students who participate in the online math program will report that their math skills have not improved.

CHAPTER 4

Analysis of the Data

Introduction

Chapter 4 has been organized around the following topics: (a) description of environment, (b) hypothesis, (c) results of the study, (d) findings, and (e) summary. This section provides a paraphrased statement of the research concern which the study has addressed.

Description of the Environment

This project was delimited to five grade level four to 12th grade mathematics classes at New Horizon School. The project was conducted during 2015-2016 school year, with 29 students. There were 8 girls in the study group and 21 boys. 2 have passed the math Smarter Balanced Assessment.. New Horizon School had an enrollment of 48 students in the fall count of 2015. The ethnicity of New Horizon School participants was White:25 Hispanic: 1 American Indians/Alaskan Native:0, African American 0, Asian: 3 and multi-racial:1. There were 16 Special Education students with Individualized Educational Plans involved in the study. 12 of the participants were diagnosed with Autism, 12 of the participants were diagnosed with an attention based disability. There were 8 classroom teachers, of results was tabulated into an Excel spreadsheet and graphs were made. Stat Pak was used to determine significance.

Summary

This chapter was designed to review the methodology and treatment of data related to the effectiveness of an incremental math curriculum and an online math curriculum. The research was Quasi-Experimental and approved by the school administrator. The participants were all the students who were using the online math curriculum in the school. They were assessed on grades and on growth via placement tests. Gradequick, Excel, and Stat Pak were the major instruments being used along with a survey created by the researcher and the Saxon Mid Grades Placement Test. The survey was given at the end of the 3 months of exclusive use of the online curriculum. The procedure was outline above and utilized data collected from grade reports, surveys, and placement tests. Data was tabulated on Excel with graphs created.

Surveys with results of participant perceived efficacy were put in a table and results before and after were compared and diagrammed (see table 3). This was done to provide a view on student perceptions as a result of the online math curriculum.

The researcher then calculated and compared rate of grade improvement for workbook based and online curriculums. The researcher then made graphs and analyzed the data.

A conclusion was drawn regarding the effectiveness of the online math curriculum in comparison to the workbook based curriculum. This conclusion was based upon the research done during the course of this study

Results were placed in a document and shared with staff, school board, and administration. This thus provided data to the school administration to be able to determine the efficacy of the two curriculum types and then make decisions regarding long term curricular plans.

Treatment of Data

Data from the participant grades was tabulated into an Excel spreadsheet and graphs were made. Data from the participant grades on the pre and post-test was tabulated into an Excel spreadsheet and graphs were made. Data from the survey designated period of time, the staff learned and utilized the online math curriculum to track student progress and learned how to use it to provide better educational guidance to students.

All participants were assessed by the instructors after 3 months of exclusive use of the online curriculum. Instructors assessed them by their overall progress, effort, and accuracies in their answers. Grades were then entered in the Gradequick program

Participants were given the Saxon Mid-Grades Placement test again as a post-test after 3 months of exclusive use of the online curriculum. This was provided by the researcher to the staff who then provided it to the participants. After it was completed, the researcher collected the tests and scored them.

Participants were given a survey after the 3 months of exclusive use of the online curriculum. Staff were provided the survey by the researcher and provided them to their students. After completion by the students on April 18th, it was collected and tabulated by the researcher.

The researcher put the Semester grades for the 3 months before full online curriculum implementation and after 3 months of full online curriculum implementation into a spreadsheet and calculated the rate of improvement in grades. (see table 2)

A review of selected literature was conducted at New Horizon School, Heritage University, Highline Community College, and internet search engines. The review of literature was provided in Chapter 2. This review provided a framework of background information for the research to take place.

All participants were graded at the end of the first and second semester of the 2015-2016 school year by staff. Staff graded them on a scale of 1-100 with letter grades that corresponded to the scale grade. The grades entered were then entered by the administration onto the student report cards.

A 10 question survey was written by the researcher. (appendix B). This survey was written with a 4 point scale and 10 questions total. This survey was then approved by the administration and fellow staff.

Participants were given a placement test before the exclusive use of the online math curriculum. The placement tests provided was the Saxon Mid-Grades Math Placement test. This was given by staff to students. After students completed the test, the researcher collected and scored the tests.

Participants utilized the online curriculum exclusively for 3 months. Their math classes used ALEKS as the primary instructional method for most of the students of the school, participants were only selected from the students making extensive use of the online math curriculum. Throughout the course of the functionality of the new curriculum over the older curriculum as expressed by the staff.

Design

This project had a pre and post-test design. The pretest data entered was the group grades during the 1st Semester 2015-2016 year. The post-test data was taken from the 2nd Semester of the 2015-2016 year. The pre-test of the group skills via the placement test was given at the end of the 1st Semester, the Post test for group skills was given at the end of the 3rd quarter of the 2015-2016 year.

The survey was designed with options out of 4. 4 meant the participant strongly agreed, 3 meant the participant agreed, 2 meant the participant disagreed, and 1 meant the participant strongly disagreed. Questions were arranged to address the various aspects of mathematic and judge the efficacy that the participants felt at that aspect of mathematics.

Procedure

Permission to conduct research at New Horizon School was granted by Principal Marla Veliz (see appendix A). Permission was given on November 10th. Parents of Participants were informed of the research with options to deny consent on January 28th to participants before and after the 3rd quarter where classes primarily used the ALEKS software. Thus this gave an accurate impression of their growth in regards to curriculum instruction they had already received.

Internal validity threats were maturation, mortality, and statistical regression. History was not a threat to validity because study didn't take over a long enough period of time. Maturation was a threat to internal validity as some participants grew in their skills over the period of time and they could have experienced sudden growth regardless of the instruction provided. Testing was not a concern due to the months between the pre and posttest ensuring the group didn't have time to develop familiarity with the test. Mortality was a concern as participants left and entered the school which eliminated some participants who left and newer students only received the newer online based instruction and didn't receive the older instruction. Statistical regression was a concern as participants at either extreme of initial results should experience some change in their progress.

External validity threats were the Novelty effect, whereby participants just exposed to ALEKS could demonstrate a greater interest due to the new medium and the Experimenter Effect where the researcher had a bias towards the

All members of the group were given the survey. The survey was designed with a 4 point scale. The scale went from 1-4 with 4 being strongly agreeing and 1 being strongly disagreeing with a statement. By doing so, the group was unable to choose a neutral response and forced to choose an answer that directly supported or didn't support a statement. The group received the survey on April 18th 2016.

Group grades were collected by means of the Gradequick gradebook software. This was done by the researcher looking at teacher gradebooks with permission from the teacher. Grades were collected for the entire year with data entered for 1st, 2nd, 3rd, and 4th quarters of the selected students.

The researcher tried to limit variables to ensure validity where possible. Students were provided the placement test on the same date by the teachers and with similar structure of presentation. Placement tests were graded by the researcher to reduce variability in assessment. Data was collected and gathered on spreadsheets by the researcher with data points double checked by the researcher. Survey was created by the researcher and data entered by the researcher. Stat Pak was used to determine significance of data results.

The Saxon Mid Grades placement test was used to determine the growth of student skills. This was chosen due to the closeness it aligned with the Saxon Math Curriculum that students received during the first semester. This was given

Participants

The project was conducted during 2015-2016 school year, with 29 participants. There were 8 girls in the study group and 21 boys. 2 have passed the math Smarter Balanced Assessment. New Horizon School had an enrollment of 48 students in the fall count of 2015. 29 participants from New Horizon School were involved in the study. The ethnicity of New Horizon School participants was White:25 Hispanic: 1 American Indians/Alaskan Native:0, African American 0, Asian: 3 and multi-racial:1. There were 16 Special Education Participants with Individualized Educational Plans involved in the study. 12 of the participants were diagnosed with Autism, 12 of the participants were diagnosed with an attention based disability.

Instruments

The data gathering devices used were participant grades gathered from Gradequick, spreadsheets on Microsoft Excel, pre and post tests, and surveys. Student grades were used to determine rates of progress for students on Saxons. Pre and Post tests were given to group before and after primary focus upon ALEKS, Surveys were given after one quarter of primary use of ALEKS for math instruction, and Excel spreadsheets were used to enter and analyze data collected.

variable, unlike Pre-Experimental, it also didn't fit the controlled environment and limited variables of True-Experimental. Quasi Experimental Design fit that criteria

The experiment used Nonequivalent Control group design. This used the same group assessed before and after instruction in Saxon Mathematics and then were given a pre and post test with the ALEKS online math curriculum. The groups for the control and experiment included the same participants so are equivalent. The variable was the math instruction the participants received.

Permission was granted by Marla Veliz, the administrator for New Horizon School. The study went from September 8^{th} to June 14^{th}.

The purpose of this study was to find out the effectiveness of the ALEKS online math curriculum compared to the Saxon Incremental Math curriculum. This information was then provided to the administration to provide information for future decision making.

The collected data was entered into a statistical calculator (Stat Pak) and a t-test. The results of the t-test were then compared to distribution of t table to ascertain if the treatment did provide a significant change in lesson delivery.

CHAPTER 3

Methodology and Treatment of the Data

Introduction

This chapter has been organized around the following topics: (a) Methodology, (b) Participants, (c) Instruments, (d) Design, (e) Procedure, (f) Treatment of the Data, (g) Summary.

Methodology

The researcher determined that the best method for this study was Quasi-Experimental with Action Research. Based on Action research, the study was conducted in location. Quasi-Experimental design according to Gay, Mills, and Airasian in *Educational Research: Competencies for Analysis and Applications Copyright 2012* involves testing an experimental hypothesis in an experiment that. allows some manipulation of variables.

The researcher used Quasi-Experimental Design due to the nature of the environment where the research took place. In True-Experimental (According to Gray et al), groups are arranged randomly with a control group and a posttest only control group. The group studied had numerous outside factors that effected growth and impacted the research in ways which could not be controlled or directly manipulated by the researcher. Thus while this research did test a using nonverbal textbooks that broke down the steps to smallest parts for students to copy. She found the process bored her students and that many never progressed even to division. She pointed out the limited research done in the subject and pushed for an increase in research and analysis to determine better techniques of teaching ELL students

Claude Goldberg (2008) described in another article the importance that ELL instruction should be based more on research than politics. He pointed out that ELL students scored significantly below non ELL students in classrooms and that support for ELL students was limited. He pointed out that the more information that both ELL and non ELL students benefitted from explicit instruction in language and literacy, focus on vocabulary. Thus, in a math curriculum, it would be important for language and vocabulary to be addressed.

Summary

The focus of this chapter was to address the available evidence to the topics of Knowledge space theory and computer based learning. The research overall supported the idea that technology based instruction and knowledge space theory is effective at supporting student learning.

students with learning disabilities. Students were administered one form via traditional paper and pencil test and the other via a computer-based system with option text-to-speech. Results indicated an increase on scores with the text-to-speech options. Students also demonstrated a preference for the text-to-speech and computer options as well. The results support the use of digital technology in creating Universally Designed assessments that fairly and accurately test students with disabilities.

ELL and Math Instruction

A team of researchers (Ganesh and Middleton (2006) studied the methods that technology tools were used in math education in a Title 1 school. They were trying to determine the methods and actions a mathematics specialist and teachers used to deliver education using the available technology for English Language Learners (ELL) and non ELL students. They found that the primary factor limiting student ability to access the instruction with technology was language. The software's lack of modeling and manipulative tools prevented the ELL students from accessing the instruction they were being provided.

In an editorial, Suzanne Irujo (April 2007) pointed out that most math instruction being recommended for bilingual and ELL students was based on the belief that math was nonverbal. She was expected to teach bilingual students

Universal Design and Assessment

Universal Design is explained by the Wyoming Institute for Disabilities as the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation of specialized design (definition by Ron Mace). When Universal Design Principles are applied, products and environments meet the needs of potential users with a wide-variety of characteristics. Disability is just one of many characteristics that an individual might possess (Sheryl Burgstahler). The major principles of Universal Design are that instruction and environments are equitable, Flexible, Simple/intuitive, with perceptible information, tolerance for error, low physical effort, and size and space for approach and use. These principles that then become accepted as required to be applied to special education.

Sheryl Burgstahler in 2001 of the University of Washington published a study on how faculty could use principles of Universal Design of Instruction and how Universal Design principles to maximize learning for all college students including those with disabilities.

In 2005, a group studied testing accommodations for large scale assessment. They used two contrasting methods to provide equivalent forms of national Assessment of Education Progress U.S. history and civics test to 10 high school (n.d.) Retrieved January 17, 2016, from http://www.hmco.com/shop/education-curriculum/math/saxon-math

Matthew K. Burns of the University of Minnesota in 2005 researched the use of incremental rehearsal to increase fluency of Single Digit Multiplication Facts for children identified as learning disabled in mathematics computation. By use of the method, he found that students demonstrated dramatic improvement in their math facts with a large standard deviation. Burns, M. Using Incremental Rehearsal to Increases Fluency of Single-Digit Multiplication Facts with Children Identified as Learning Disabled in Mathematics Computation.

In 2006, Susumu Hayashi of Kyoto University studied the learning of mathematics based on theory that was introduced to students. The study ultimately suggested that logic and learning theory were strongly connected.

In 2003, Susie Bolser and David Gilman did research on the Saxon math system at Fountain Elementary School. By comparing scores of 3rd grade students before and after implementation of the Saxon Math System to the students' ISTEP scores, they concluded that implementing the Saxon Math program had a significant effect on the mean scores in math on the students ISTEP test.

results of student understanding of the Bonding Concept in general and organic chemistry. They concluded that the student understanding of the concept was superficial and non-transferable. They felt that Knowledge Space Theory analysis provided a remedy to this problem.

In 2005, a team from the University of California led by Arasasingham R. and Taagepera M. researched the use of Knowledge Space Theory to assess impact of Web based instruction on student understanding of stoichiometry. They used a program called Mastering Chemistry Web. Their analysis of Knowledge Space Theory concluded that both groups made significant improvement in stoichiometry but that the group using the software had greater improvement than the ones not using the software. The students themselves concluded that Stoichiometric reasoning was difficult but the software did help.

Incremental Learning and Saxon

The Saxon Math was developed in the 1980s with demonstrated results in grades from Kindergarten to High school. It uses an incremental structure to distribute content throughout the year. By doing so, Houghton Mifflin Harcourt Company claims that it provides deep, long term mastery of content and skills in accord with Common Core State Standards. Saxon math is typically taught by way of workbooks with scripted direct instruction for the instructor. Saxon Math learners. Albert, D. Adaptive and Dynamic Hypertext Tutoring Systems Based on Knowledge Space Theory

In 1997 Martin Schrepp of Ladenburg, Germany took the ideas of knowledge spaces that was previously based entirely upon answers either being incorrect or correct, and then hypothesized a framework for the theory to be applied to a problem with more than 2 answers. The research concluded that response patterns of individuals could provide a pattern that can fit the general structure and programming of Knowledge Space theory. Martin Schrepp Generalization of Knowledge Space Theory to Problems with More than Two Answer Alternatives

This was further expanded by Albert D. and Hockemeyer in 1999 when they did research on Developing Curricula for Tutoring systems based on Prerequisite Relationships. They created an adaptive tutoring system that used the prerequisite relationships between learning objects within a course and then linked them to new objects that were then presented to the student. They designed it around large collections of learning objects that were provided and the curriculum was then developed and restructured, Albert, D. Developing Curricula for Tutoring Systems Based on Prerequisite Relationships

In 2002, a team lead by Taagepera M. and Arasasingham R. from the University of California used Knowledge Space Theory approach to analyze the program. Overview of ALEKS (n.d) Retrieved January 17, 2016, from https://www.aleks.com/about_aleks/overview

Knowledge by Space Theory was originally developed a team lead by Jean-Claude Falmigne. This assessment was based on the idea that the type of programs that can be asked in any assessment come from a large collection encompassing the full curriculum for the topic. They summarized the basic concepts of learning spaces and reported on whether such an assessment was able to predict a subjects' responses to problems that were not part of the assessment. In each assessment, an additional question was asked and the response was predictable from the assessed states. This theory of adaptive assessment was the foundation for Knowledge Space Theory and the basic idea behind the ALEKS online math curriculum. Falmagne J et al. Assessing Mathematical Knowledge in a Learning Space: Validity and/or Reliability

Albert D. In 1997 then performed additional research based on Knowledge Space Theory. By utilizing hypertexts to form a structure he applied Knowledge Space Theory to a framework for intelligent tutoring systems that provided individualized learning. Utilizing this format and applying Knowledge Space Theory he was able to provide an effective selection of teaching documents to

Andrew C. Porter and Jere Brophy posted an article that attempted to synthesize research on good teaching and ultimately concluded that the research strongly supported that good teaching contains many aspects including making use of instructional materials to spend more time on high quality and enriching practices. Porter, A and Brophy B., Synthesis of Research on Good Teaching.

<u>ALEKS and Knowledge Space Theory</u>

The Assessment and Learning in Knowledge Spaces program was designed based on Knowledge Space Theory begun in the 1980s by Dr. Jean-Claude Falmagne. It utilized artificial intelligence software to assess a student's current knowledge through a small battery of questions, each question was unique and chosen based on a student's prior answers. By means of the assessment the program had a picture of the student's current knowledge, which topics haven't been mastered, and then in learning mode provided a list of topics for the student to learn which the program then taught the student. It also combines a periodic reassessment of the student in order to ensure mastery was maintained. The student was then provided learning opportunities that the program determined were based on a student's current learning potential and then taught to the student by the program. The program listed learning rates as being 90% with the ALEKS

December 29, 2015 from http://www.edweek.org/ew/articles/2015/03/18/review-of-math-programs-comes-under-fire.html

David Shoenthal of Longwood University taught an in person and online math program. He managed his online math program by the same principles he used for his in person class and found that overall his online math course saw significant improvement. He then saw overall success in his online math course. (n.d.). Retrieved December 29, 2015, from http://scholarship.claremont.edu/cgi/viewcontent.cgi?article=1167&context=jhm

Workbook vs Technology based instruction.

Noriko Nagata of the University of San Francisco did a comparison of workbook based instruction and computer based instruction in terms of Second Language Acquisition. He employed a language processing program called CALI (Japanese Computer Assisted Language Instruction) and them compared it with a non CALI workbook based instruction in a self study environment. His research found that intelligent computer feedback is more effective than workbook answer sheets for developing grammatical skills. Improved feedback from an intelligent software program was judged to be more effective than notes put on a workbook answer sheet. Nagata, N. Computer vs Workbook Instruction in Second Language Acquisition. 1996

17, 2016 from http://www.understood.org/en/school-learning/special-services/ieps/understanding-individualized-education-programs

Online Math Programs

In a legislative update following concerns about budgeting, Senator Patty Murray explained that as a country we cannot lead the global economy without a prepared workforce. Children must be provided high quality education from preschool to the time they entered their careers. To achieve this, there is a push by Discovery Education to transition more students to digital programs and classrooms. Legislative Update: March 5,2014 – National Council of Teachers of Mathematics. (n.d.).Retrieved December 29, 2015, from http://www.nctm.org/Research-and-Advocacy/advocacy-in-the-field/Legislative-Update/Legislative-Update_-March5,-2014

The state of math education curriculum in America was discovered by the non profit EdReports.org that all but one curriculum used in America failed to meet the Common Core State Standards. This was determined by setting thresholds that the math programs were required to meet in order to prove whether or not it met the objectives in the Common Core State Standards. This has added to the overall push to establish other forms of math instruction including online education. Review of Math Programs Comes Under Fire. (n.d.). Retrieved of IDEA and provide a more inclusive educational experience for students with various mental and physical disabilities.

IEP's

Christina A Samuels in November 2015 found a decrease on NAEP (National Assessment of Educational Progress) for students with disabilities. The lack of scores demonstrated that students with disabilities were gaining no ground on closing achievement gap when compared to students without disabilities. 33% of 4th graders with disabilities scored at or above basic level while 74% of students without disabilities achieved a score at or above basic. For the 8th grade reading test, 37% of students with disabilities achieved at or above basic while 81% of students without disabilities had a score at or above basic.

The Individuals with Disabilities Education Act (IDEA) requires that every student receiving special education services have an educational plan that addressed each child's unique learning issues and includes special educational goals. An IEP is a legally binding document and schools are required by law to provide everything promised on a student's IEP. IDEA gives parents legal right to participate in their child's IEP meetings as part of the child's IEP team. Goals are established with a structure for regular measurement to determine progress to goal. Understanding Individualized Education Programs (2014) Retrieved January based research as defined by WAC 172a-01165. This is defined as "research that involves the application of rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs". (WAC 392-172A-01165. Scientifically based research. (n.d.) Retrieved December 2, 2015, from http://apps.leg.wa.gov/WAC/default.aspx?cite=392-172A-01165)) It also specified the importance of ensuring measurements and methods are reliable and valid and research was provided with sufficient clarity to allow replication.

The state of Washington stated that to ensure Washington Schools were meeting the objective of IDEA, that the principles of Universal Design must be applied within a classroom setting (WAC 392-172a-01195. Universal design. (n.d.) Retrieved December 2, 2015 from http://apps.leg.wa.gov/WAC/default.aspx?cite-392-172a-01195). Universal Design specified that educational products and service must be designed and delivered to be usable by those with the widest range of functional capabilities. This required educators and administrators to present their materials and methods in a manner that was accessible to as students of many different functional capacities. Teachers were required then to ensure all aspects of their teaching met with the principles of Universal Design which would in turn meet the objectives with disabilities received the same educational opportunities that are available to those without disabilities. This was divided into 3 parts. Part A specified the provisions of the law in general, Part B discussed the assistance offered for students with disabilities, Part C deals with infants and toddlers with disabilities, and Part D covers national programs to support this that are managed by the Federal Government. Part B Subsection A specifies the purpose of IDEA is to provide education that meets the needs of special education students and prepares them for further education, careers, and living skills (Subpart A of the Part B Regulations: General Provisions | Center for Parent Information and Resources (n.d.) Retrieved December 2 2015, from http://www.parentcenterhub.org/repository/partb-subparta/#300.1). It also specified that methods used must be assessed to ensure their effectiveness at teaching students with disabilities.

Washington State has enacted its own regulations to ensure compliance with Race to the Top, IDEA, and NCLB. It specifies in WAC 392-172a-01045 (WAC 293-172A-01045: Core academic subjects. (n.d.) Retrieved December 2, 2015 from http://app.leg.wa.gov/wac/default.aspx?cite=302-172a-01045) that the core academic subjects are English, Reading/Language Arts, Economics, Arts, History, and Geography. The teaching must be done in methods based on scientifically by the previous academic standards. This would be managed in part by holding educational institutions responsible for the success of their students and providing modifications and alternatives when high quality learning opportunities WERE not proved to be available to students.

NCLB was based in part on a previous concern that was expressed with a 1983 Article titled A Nation At Risk. This article recommended that graduation requirements should require students took a minimum of 4 years of English, 3 years of mathematics, 3 years of science, 3 years of social studies, and half a year of computer science. (Recommendations. (n.d.) Retrieved December 2, 2015 from http://www2.ed.gov/pubs/natatrisk/recomm.html) It provided a set of basic guidelines students had to meet in order to be successful. It also recommended that students be assigned more homework, learned study skills, and required higher standards for teachers. Race to the Top concluded with the statement that lawmakers believed that these standards would ensure success for the students at the time and set the framework for long-term success.

While the government was trying to raise standards it was also working to address the needs of disabled students in the Education for all Handicapped Children Act (EHA) which was later changed in 1990 to the Individuals with Disabilities Education Act (IDEA). The goal of IDEA was to ensure that students

CHAPTER 2

Review of Selected Literature

Introduction

This chapter has been organized around the following topics: (a) No Child Left Behind and IDEA (b) IEP's (c) Online Math Programs (d) Workbook based learning (e) ALEKS and Knowledge Space Theory, (f) Saxon and Incremental Learning, (g) Assessment and Universal Design, ELL and Math Instruction (h) and (i) summary.

No Child Left Behind and IDEA

No Child Left Behind Act (NCLB) was enacted in 2001 under the administration of President George W. Bush. It was also referred to as the Elementary and Secondary Education Act (ESEA). It was enacted in order to provide a structure whereby all students have fair, equal, and significant opportunity to obtain a high-quality education and reach a minimum proficiency on state academic achieving standards and academic assessments. (Title 1 – Improving the Academic Achievement of the Disadvantaged (n.d.) Retrieved December 2, 2015, from http://www2.ed.gov/policy/elsec/leg/esea02/pg1.html) . This act was intended to provide more resources to low achieving students in high risk schools, students with disabilities, and other students who were not being met math skill: Ability to effectively and repeatedly use mathematical principles to solve grade level appropriate problems and concepts.

Acronym

NCLB- No Child Left behind.

IDEA- Individuals with Disabilities Act.

ALEKS- Assessment and Learning in Knowledge Spaces

NHS- New Horizon School

IEP- Individualized Educational Plan

UD- Universal Design

OSPI- Office of Superintendent of Public Instruction.

11. Surveys with results of participant perceived efficacy were put in a table and results before and after were compared and diagrammed (see table 3)
12. The researcher then calculated and compared rate of growth for workbook based and online curriculums. Teacher made graphs and analyzed the data.
13. A conclusion was drawn regarding the effectiveness of the online math curriculum in comparison to the workbook based curriculum.
14. Results were placed in a document and shared with staff, school board, and administration.

Definition of Terms

For the purpose of this study, the following words are defined:

incremental learning: Learning that presents only one or two new ideas at a time while majority of lesson is a view of previous material.

online curriculum: A math curriculum that is designed to be exclusively accessed and used through a computer with the computer program assessing and adapting instruction for students.

2. A review of selected literature was conducted at New Horizon School, Heritage University, Highline Community College, and internet search engines
3. All participants were graded at the end of the first and second semester of the 2015-2016 school year by staff.
4. A 10 question survey was written by the researcher. (appendix B)
5. Participants were given a placement test before the exclusive use of the online math curriculum.
6. Participants utilized the online curriculum exclusively for 3 months
7. All participants were assessed by the instructors after 3 months of exclusive use of the online curriculum
8. Participants were given a after 3 months of exclusive use of the online curriculum
9. Participants were given a survey after the 3 months of exclusive use of the online curriculum.
10. The researcher put the Semester grades for the 3 months before full online curriculum implementation and after 3 months of full online curriculum implementation into a spreadsheet and calculated the rate of improvement in grades. Results were placed in a spreadsheet (see table 2)

Significance of the Project

The purpose of this project was to provide a factual base of information regarding the effectiveness of online Knowledge Space based math instruction over an incremental workbook based math curriculum. If the online program proved more effective, then it would be recommended to the school that the program was a more effective method and then school would be able to phase out the workbook based curriculum. If it turned out the online program was less effective, then it would be discontinued by the school until further analysis could be done to find an effective alternative to the workbook based curriculum. In that case, the school would then continue to buy and depend on the workbook based curriculum. If results demonstrated success with some groups over others, then further data analysis would then be needed to determine the best method for the school to use.

Procedure

For the purpose of this project, the following procedures were implemented: ----

1. Permission to conduct research at New Horizon School was granted by Principal Marla Veliz (see appendix A)

and that Students did their best on the surveys and answered consistently. The researcher also assumed that Students attended class regularly, Teachers were familiar with Saxon and ALEKS when it was presented to the students, provided consistent support for each and Student math skills did not have change as a result of the summer.

Hypothesis

Students who use the online math curriculum will experience significant growth in math grades when compared to the students who use the non-online curriculum. Students who use the online math curriculum will have a higher percentage of growth in math concepts when compared to the students who use the non-online curriculum. Students who participate in the online math program will report that their math skills have improved.

Null Hypothesis

Students who use the online math curriculum will not experience significant growth in math skills when compared to the students who use the non-online curriculum. Students who use the online math curriculum will have a lower percentage of growth in math concepts when compared to the students who use the non-online curriculum. Students who participate in the online math program will report that their math skills have not improved.

Delimitations

This project was delimited to five grade level four to 12^{th} grade mathematics classes at New Horizon School. The project was conducted during 2015-2016 school year, with 29 students. There were 8 girls in the study group and 21 boys. 2 have passed the math Smarter Balanced Assessment. New Horizon School had an enrollment of 48 students in the fall count of 2015. The ethnicity of New Horizon School participants was White:25 Hispanic: 1 American Indians/Alaskan Native:0, African American 0, Asian: 3 and multi-racial:1. There were 16 Special Education students with Individualized Educational Plans involved in the study. 12 of the participants were diagnosed with Autism, 12 of the participants were diagnosed with an attention based disability. There were 8 classroom teachers, of which 3 had their masters degree. However 100% of the teachers were highly qualified (office of Superintendent of Public Instruction).

Assumptions

For this study it was assumed that Students were familiar with the curriculums when they were using them. Also it was assumed that Students tried their best on their work as well as students asked questions when they were confused. It was assumed that teachers were also consistent in their assessment of student skills

Statement of the Problem

New Horizon School (NHS) looked at their math scores and student progress, and our assessment from the accreditation committee and determined a need to change its math curriculum. Students with disabilities were struggling with the individualized instruction offered by the Saxon workbook and teachers struggled to accurately assess and improve student math skills.

The lead teacher and the administration met and tested out the Assessment and Learning in Knowledge Spaces program (ALEKS) during summer school interventions and felt it was a better method for individualized instruction than the previous Saxon model. Staff met and determined to test out the program for the staff to determine whether it was more effective than the previous workbook based program. This study was to determine whether the implementation of ALEKS was more effective than the previous Saxon curriculum.

Purpose of the Project

The purpose of this study was to determine if students who used the online math curriculum experienced growth in math grades and skills when compared to the students who used the non-online curriculum. In addition, students involved in the online math program would report their math skills improved as a result of the online math curriculum.

computer based learning was more effective for students than students using a workbook when working independently.

New Horizon School decided to use Assessment and Learning in Knowledge Spaces (software) for the online curriculum. This was based on knowledge space theory created by Dr. Jean-Claude Malmagne (1994) that formed the foundation for the concept of adaptive assessment. Adaptive assessment to create intelligent learning systems was the foundation for the ALEKS curriculum.

The Saxon math curriculum used previously in the year of the study was based on incremental rehearsal of math facts. Burns (2005) discovered that using incremental rehearsal for single digit multiplication facts, that students demonstrated dramatic improvement in their math facts.

The curriculums that were chosen were based on the New Horizon School's adherence to the principle of Universal Design. Burgstahler (2001) pointed out that there was a variety of principles, products, and environmental changes that could improve the education the education of all learners and not just learners with disabilities. The ALEKS curriculum fit the principles of Universal Design clearly in the minds of the school administration and thus better met the objectives of the school, student IEPs, and principles of Universal Design.

opportunities as those without disabilities. Students with Disabilities were required to receive a high quality education.

Christina A Samuels (2015) discovered that scores for students with disabilities were decreasing. This meant that over time, many students with identified disabilities scored consistently below the level of students without disabilities. This trend went against the legally binding requirements that are included in many IEPs (Individualized Educational Plan) for students with disabilities to provide the education a student requires.

Patty Murray (2014) said that the global economy required a prepared workforce and this lead to a push to transition many students to digital programs and digital classrooms. When math programs in America were reviewed by EdReports.org (2015), it was discovered that all but one curriculum in America failed to meet the Common Core State Standards. Together they established a need for new curriculums to be used in the classroom and the advantage of an online math based curriculum for student preparation.

Noriko Nagata (1996) compared workbook and computer based instruction for language instruction and concluded that the computer feedback was more effective than workbook answer sheets. This supported the idea that intelligent

CHAPTER 1

Introduction

Background for the Project

New Horizon School tried to determine the best way to improve the teaching of mathematics. The school had a population with multiple disabilities and many students had individualized educational plans that expressed the need for high quality mathematics instructional methodology. The school previously used the Saxon incremental math curriculum, but many students struggled with that math curriculum. The school implemented the Assessment and Learning in Knowledge Spaces curriculum to determine if it provided students a better learning experience. This research was done to determine the effectiveness of the new program for the student population at New Horizon School.

No Child Left behind and IDEA both addressed the need for high quality instruction. No Child Left Behind was enacted in 2001 under the Bush administration to provide equal opportunities and to provide a high quality education to all students. Individual with Disabilities Act was established to ensure that students with disabilities received the same education and

LIST OF FIGURES

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PERMISSION TO STORE

I, Richard Nordlander, hereby irrevocably consent and authorize Heritage University Library to file the attached Special Project entitled, *An Analysis of the Implementation of Assessment and Learning In Knowledge Spaces Mathematical Program,* and make such Project and flash drive available for the use, circulation and/or reproduction by the Library. The Project and flash drive may be used at Heritage University Library and all site locations.

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Rich Nor________________________________, Author

7/7/2016________________________________, Date

ABSTRACT

Title

Researcher: Richard Nordlander, B.A. in History/Social Studies, WWU

M.Ed., Heritage University

Chair Advisory Committee: Robert P. Kraig, PhD.

This research analysed the implementation of the ALEKS (Assessment and Learning in Knowledge Space) program in a private school. Students grades were recorded and placement tests given to students before the full implementation of the ALEKS software. After one quarter of exclusive use of the ALEKS software for the mathematics, student grades were recorded, placement tests completed, and students were surveyed for their impressions. Students felt that overall they improved, however, grades showed a significant drop and placement tests had an increase in math skills but not enough to be significant. Ultimately it was concluded the duration and areas of measurement used for this research was not sufficient to adequately assess the situation and growth for the students.

FACULTY APPROVAL

An Analysis of the Implementation of Assessment and Learning in Knowledge

Spaces Mathematical Program

A Master's Special Project

by

Richard Nordlander

Approved for the Faculty

Robert P Kraig, Faculty Advisor

Dr. Robert P. Kraig

7/9/2016, Date

An Analysis of the Implementation of Assessment and Learning in Knowledge Spaces Mathematical Program.

A Special Project

Presented to

Dr. Robert P. Kraig

Heritage University

In Partial Fulfillment

of the Requirements for the Degree of

Masters in Education – Teacher Leadership, ESL

Richard Nordlander

July 7 2016