Exploring the Effects the SIOP Model has on Low SES Students’ Mathematical Number Sense
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Abstract

The purpose of this study was to determine the effects that sheltered instruction observation protocol (SIOP) had on Low Socioeconomic Status (SES)/Title I students’ mathematical number sense. There has been an area of concern in mathematical language among English Language Learners (ELLs) (Gamez, Levine, 2013) and a correlation between low-SES students and mathematical achievement, confidence and interest (Yang, Lai, Yao, Huang, 2014). Studies have also shown that students with mathematical difficulties in the area of problem solving showed the most improvement under the testing conditions, which were verbal and visual instruction (Swanson, Orosco, & Lussier, 2014). The study consisted of 17 sixth grade students enrolled at Kenowa Hills Middle School. Each participant took a pretest and the scores were collected and averaged for each of the eight Number Sense Common Core State Standards (CCSS). The principal investigator then used the SIOP model to teach these eight Common Core State Standards and had participants take the district created assessment as a posttest. These scores were averaged and put into a Pearson’s $r$ Correlation chart to determine if there was a correlation with the instructional model and improved scores. The results from this research were varied. Each CCSS had a different result. Two of the standards had a strong positive relationship according to the correlation chart found in the appendix. This can be interpreted that the SIOP model was an effective lesson delivery for these two particular standards. One of the standards showed a moderate positive relationship. Two standards had a weak positive relationship and two showed no relationship.
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Exploring the Effects the SIOP Model has on Low SES Students’ Mathematical Number Sense

Chapter 1 - Problem

Introduction

There has been an area of concern in mathematical language among English Language Learners (ELLs) (Gamez, Levine, 2013) and a correlation between low-Socio-Economic Status (SES) students and mathematical achievement, confidence and interest (Yang, Lai, Yao, Huang, 2014). Studies also have shown that students with mathematical difficulties in the area of problem solving showed the most improvement under the testing conditions, which were verbal and visual instruction (Swanson, Orosco, & Lussier, 2014). Research has shown that an emphasis on language while teaching mathematics has been essential and teacher-training programs need to implement these strategies into their training programs (Chval, Pinnow, Thomas, 2015). This evidence has supported the need for teacher training in the sheltered instruction observation protocol model (SIOP Model), which has been a major focus of this study as our students showed a need for improvement in the area of academic vocabulary, and the SIOP Model could help to keep the vocabulary at the forefront of the lesson.

Since the literature states that the sheltered instruction observation protocol (SIOP) benefited English Language Learners, because of the similarities shown in literature between ELLs and Title I students on math achievement, the researcher has wondered whether the SIOP model would benefit low SES students as well. SIOP has been an effective and researched instructional model that has supported teachers in planning and delivering instruction that can support all students, especially English
Language Learners. It has been the goal of the researcher to explore the effects the SIOP Model has had on Title I students and their mathematical number sense.

Justification of the Study

Completion of this study has shown improved teaching practices for all educators and students and has provided them with more tools for learning during their school career. This study has shed light on the importance of differentiation based on student need and still has provided the educator with tools and resources that has helped the students. In turn students have increased their understanding and performed better on assessments and in the classroom.

Null Hypothesis

There is no relationship between the effect of the SIOP model and Title I, sixth grade students’ mathematical number sense.

Independent Variable: Number Sense Assessment

Dependent Variable: Use of the SIOP Model
Definition of Terms

This study referenced several different terms, which included…

**SES:**


Socioeconomic status (SES) has often been measured as a combination of education, income and occupation.

Operational Definition: Describes the students that have been considered low income (Title I) receiving free and reduced lunch.

**SIOP Model:**


The sheltered instruction observation protocol (SIOP) Model has been a research-based and validated instructional model that has been proven effective in addressing the academic needs of English learners throughout the United States.

Operational Definition: the planning and delivery of student-centered lessons with an emphasis on language and the language standards.
Chapter 2 - Background and Review of Literature

Background

Many scholars have agreed that socioeconomic status (SES) has contributed to the availability and distribution of materials. Additionally, SES has impacted all realms of behavioral and social science and had included research, education, practice, and advocacy (APA, 2016). According to (Deanda, Arias-Trejo, Poulin-Dubois, Zesiger, & Friend, 2016), study results have shown that English as a Second Language (ESL) exposure and SES have had significant and independent effects on a direct measure of vocabulary comprehension in English dominant and English monolingual children, but the same has not held true for Spanish dominant or Spanish monolingual children. These results implied a sensitivity of the language system to minimal changes in the environment in early development. Language minority students and their native English-speaking classmates from similarly low socioeconomic backgrounds have benefited from early screening for risk of reading difficulties (Kieffer, Vukovic, 2013). Additionally, a child’s gender, intellectual maturity, home literacy climate and socio-economic status appeared to substantially predict reading comprehension development, directly or indirectly (Morales, Verhoeven and Leeuwe, 2011). SES and socio-cultural factors have impacted the reading growth of children. “Theories are also presented as to why there are gaps in the scores based on gender and ethnicity” (Murnane, Sawhill, & Snow, 2012). Children of professional parents speak to and use phrases that added to the child’s vocabulary at twice the rate of the children from a low-income household. “Both the quantity and quality of phrases directed at the children by caregivers correlated directly with income levels.” (Jensen, 2013). There has been a link between SES and the reading growth of children. Results have shown that lower SES was associated
with faster growth rates at the primary level and slower rates of growth from 3-8 grades. Findings also supported an increased attention from researchers and educators to the reading achievement gaps after 3rd grade (Kieffer, 2012). Additionally there has been a deficit in mathematical language among English Language Learners (ELLs) (Gamez, Levine, 2013) and a correlation between low-SES students and mathematical achievement, confidence and interest (Yang, Lai, Yao, Huang, 2014). Studies have also shown that students with mathematical difficulties in the area of problem solving showed the most improvement under the testing conditions, which were verbal and visual instruction (Swanson, Orosco, & Lussier, 2014).

Professional Development

Not only has it been important to identify the students for academic difficulties, we have also needed to equip our educators with the tools and strategies necessary to educate these students. The use of the 5 Positive Behavior Intervention & Supports (PBIS) strategies has been implemented to positively impact youth with emotional and behavioral disorders and has closed the achievement gap (Benner, Kutash, Nelson, & Fisher, 2013). New teachers have needed to enter the field equipped to handle the stresses of low or under achieving schools. Many educators have left the field within the first three to five years of employment. This has created a need for diverse candidates, collaborative partnerships, student support and mentorship, curriculum conceptualized for multicultural education, extended field experiences in urban settings, and induction for program graduates (Waddell, Ukpokodu, 2012).

Evidence supports the need for teacher training in the sheltered instruction observation protocol model (SIOP Model). Educators needed to be equipped to
support the multidimensional academic needs of their students. Additionally studies have shown that students that were taught under the SIOP model outperformed the students that were not taught using the SIOP Model (Luster, 2011). According to Short, Echevarría, & Richards-Tutor (2011), the SIOP model has been effective when used with fidelity and teachers that were taught to use the SIOP model had students outscoring the teachers that had no exposure to SIOP.

Although many believe that the SIOP model was designed to teach English to ELL students, it is much more. The SIOP model has helped teachers to plan and implement instruction that has allowed all students access to the content despite their language struggles.

Despite the need to provide professional development for the educators, training has not been enough. Teachers have done great things in the classroom and results will vary from child to child. A partnership that was formed to increase the effectiveness of the instruction of reading comprehension showed that the teachers’ ability to engage in effective reading comprehension instruction improved, however, outside factors impacted the data (Pomerantz, Pierce, 2013).

Lesson Models

Various lesson models have been used throughout the years. According to Wilson (2016), most models could loosely fit into one of the five “families” of educational psychology; social interaction, information processing, personalist, behavioral and constructivist. District leaders made decisions based on their philosophical orientation and based on those beliefs; they chose their favorite models. After training sessions the educator or teacher was expected to buy into the same belief. Social interaction was the belief that students learned best in social, democratic
settings. Information processing was an approach designed to focus on specific ways to learn specific data, organize the data, solve problems and develop concepts and language. Another model was the personalist, and this was where the educator acknowledged the uniqueness of the learners and used that uniqueness to create personal meaning. Behavioral was designed with structured outcomes in mind that contained observable objectives. The final “family” was constructivist, which was when lessons were designed to allow the learner the opportunity to relate information to the real world or solve real world problems. These “families” are the overarching compass that educators used to develop and design instruction. Educators had to identify with a lesson model that they felt would best suit their classrooms and curriculum. A majority of these lesson designs implore the educator to think about questions in order to develop thoughtful and informed lessons. Educators should plan lessons and or units by using seven guiding prompts; the big idea/learning goals, needs of the students, specific lessons needed during the unit to bring it to a successful conclusion, the logistical details of the unit, assessment, what the educator learned during the teaching, and what the educator learned after teaching the unit (Elementary Education Teacher Preparation, 2011). These were some of the same prompts that the sheltered instruction observation protocol used with the addition of a language component. That language component was what has helped English Language Learners.

SIOP Model

Personal experiences and the literature led one to believe, that the sheltered instruction observation protocol (SIOP) would have benefited Title I students as well. SIOP has been a proven instructional model that has supported teachers in planning
and delivering instruction that can support all students, especially English Language Learners. A study was created to determine how specific instructional practices contributed to reading proficiency. The study used multiple sources of evidence for data collection (interviews, observations, and documents). Results showed that the SIOP model, flexible grouping, and Rosetta Stone were most effective in improving reading proficiency (Smiley-Blanton, 2010).

Through this research it was determined that the extent of the effectiveness of the SIOP model for the students were evidenced through the student development of mathematical number sense skills that would assist them as they continue to develop as mathematicians.

SIOP has been shown to be an instructional model that has supported teachers in planning and delivering instruction that has supported all students, especially English Language Learners. Based on research the SIOP model has been considered effective for all students. Currently the SIOP model has only been discussed in and around the area of educating English language learners.

Title I and Academics

Study results show that English as a Second Language (ESL) exposure and SES have had significant and independent effects on a direct measure of vocabulary comprehension in English dominant and English monolingual children, but the same does not hold true for Spanish dominant or Spanish monolingual children (Deanda, Arias-Trejo, Poulin-Dubois, Zesiger, & Friend, 2016). These results implied a sensitivity of the language system to minimal changes in the environment in early development. Language minority students and their native English-speaking classmates from similarly low socioeconomic backgrounds benefit from early
screening for risk of reading difficulties (Kieffer, Vukovic, 2013). Additionally, a child’s gender, intellectual maturity, home literacy climate and socio-economic status appeared to substantially predict reading comprehension development, directly or indirectly (Morales, Verhoeven and Leeuwe, 2011). SES and socio-cultural factors have impacted the reading growth of children. “Theories are also presented as to why there are gaps in the scores based on gender and ethnicity” (Murnane, Sawhill, & Snow, 2012). There has been a link between SES and the reading growth of children. Results showed that lower SES was associated with faster growth rates at the primary level and slower rates of growth from 3-8 grades. Findings also supported an increased attention from researchers and educators to the reading achievement gaps after 3rd grade (Kieffer, 2012). Additionally there has been a deficit in mathematical language among ELLs (Gamez, Levine, 2013) and a correlation between low-SES students and mathematical achievement, confidence and interest (Yang, Lai, Yao, Huang, 2014). Studies have also shown that students with mathematical difficulties in the area of problem solving showed the most improvement under the testing conditions, which were verbal and visual instruction (Swanson, Orosco, & Lussier, 2014).

This literature in correlation with the definitions of SIOP and low SES has precipitated the need to explore the effects the SIOP Model has had on low SES students’ mathematical number sense.
Chapter 3 - Methodology

Description of the Research Design

This was correlational in nature. Correlational research design has allowed the educator to collect two sets of data from one group of participants for analysis that attempts to show a relationship between them. This design allowed the researcher to receive a base score from the pretest, apply a teaching strategy to a targeted group and then complete a posttest to determine if there is a relationship between the pretest and posttest. In this case, the principal investigator has given the students participating in the study a pretest. The teacher then designed and implemented appropriate lessons daily, using the Sheltered Instruction Observation Protocol (SIOP) model to educate the students in each area of the Common Core State Standards (CCSS) in the area of Number Sense. After lessons have been taught using the SIOP model, students then took the district created common assessment as a posttest. The average student score has been calculated and compared to the pretest data to determine the effectiveness of the lesson model. This process has been carried out for each of the eight CCSS pertaining to number sense. The pre and posttest has been used to assess one of the eight standards in the number sense strand. The participants had been asked to complete a pretest and then they had received lessons using the SIOP lesson design and delivery. The duration between the pre and posttest was approximately three weeks per standard, with a focus on one of the CCSS at a time. The purpose of this study was to explore the effects the SIOP model has had on low SES students’ mathematical number sense.
Description of the Sample
This was a group of seventeen sixth grade students from Kenowa Hills Middle School. The participants are from two different class groups. Each participant qualified as Title I, the breakdown was as follows: 18% African American/Biracial students, 12% Hispanic students and 71% White students. Two of the participants qualified as special education students under Michigan’s law.

Description of the Instruments Used
The district created pretest and posttest was used. There were eight different Common Core State Standards under the category number sense. These standards focused on addition, subtraction, multiplication and division of decimals, dividing fractions, the distributive property, absolute value, graphing rational numbers and using integers to represent real world problems. The assessment required students to respond by solving given problems and showing their work and/or explaining their solution. The students took a district created pretest and a district created posttest after the educator had developed and implemented lessons using the SIOP model in order to demonstrate that SIOP was effective for all students.

Explanations of the Specific Procedures Followed
Each student took the required pretest for the given standard, in the classroom using paper and pencil. The teacher recorded the scores on an Excel document. Each student was given a number to represent them in the study. There were two columns for each Common Core State Standard, one for the pretest data and one for the posttest data. At the bottom of each column an average percentage was calculated.
The teacher then designed and implemented appropriate lessons using the SIOP model to educate the students in each Common Core State Standard. Each of the Standards took approximately three weeks. After lessons have been taught using the SIOP model, students took the district created assessment and the data was put into the second column on the Excel spreadsheet. The average student score was calculated and compared to the pretest data to determine the effectiveness of the lesson model. This process was carried out for each of the seven Common Core State Standards pertaining to number sense.

Discussion of Internal Validity
The internal validity in this experiment was the district created assessments and the SIOP Model. The district created pretest was designed by a team of teachers to determine if students required support for that standard or if they should be challenged further. The classroom assessment designed to support day-to-day learning. These were assessments that the students were already required to take before and after each standard was taught.

Discussion of External Validity
The external validity was the student data. If the student data showed improvement from the pretest to the posttest, the SIOP Model has been considered effective for low SES students, if the student data showed a decline or no change, then the SIOP Model was considered ineffective for low SES students.
Description of the Statistical Techniques or Other Methods of Analysis Used

There were two columns for each CCSS assessment; one for the pretest data and one for the posttest data. The teacher then designed and implemented appropriate lessons using the SIOP model to educate the students in each area of the CCSS. After lessons were taught using the SIOP model, students then took the district created assessment and the data was put into the second column on the Excel spreadsheet. The principal investigator used the Pearson Correlation Coefficient for each of the eight standards to determine whether the SIOP model was effective. The Pearson Correlation Coefficient determines the level of linear dependence (correlation) between two variables. The range of values is -1 to 1, where a -1 would show a negative linear correlation, 0 would mean there is no correlation and 1 would mean a positive linear correlation (see appendix for guidelines for Pearson Correlation Coefficient). This tells us the strength of the relationship between the two variables.

This correlational study was done using the SIOP Model for lesson planning and instruction for seventeen, sixth grade Title I students. The goal was to determine if the SIOP model was effective for Title I students as well as English Language Learners.
Chapter 4 - Results, Analysis and Data

The similarities shown in literature between English Language Learners (ELLs) and Title I students on math achievement, the researcher has wondered whether the Sheltered Instruction Observation Protocol (SIOP) model would benefit low Socioeconomic Students (SES) students as well. SIOP has been an effective and researched instructional model that has supported teachers in planning and delivering instruction that can support all students, especially English Language Learners. It has been the goal of the researcher to explore the effects the SIOP Model has had on Title I students and their mathematical number sense.

Results

The results from this research were varied. Each CCSS had a different result. Two of the standards had a strong positive relationship according to the correlation chart found in the appendix. This can be interpreted that the SIOP model was an effective lesson delivery for these two particular standards. One of the standards showed a moderate positive relationship. Two standards had a weak positive relationship and two showed no relationship.

Analysis and Data

The two standards that showed a strong correlation were 6.NS.B.4: Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1-100 with a common factor as a multiple of a sum of two whole numbers with no common factor, and 6.NS.C.6: Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to
represent points on the line and in the plane with negative number coordinates (Grade 6 CCSS, 2017). The Pearson R Correlation for 6.NS.B.4 was \( r = 0.43 \) and the Pearson R Correlation for 6.NS.C.6 was \( r = 0.66 \). The following graphs represent the relationships…
EFFECTS OF SIOP MODEL ON TITLE I STUDENTS' NUMBER SENSE
EFFECTS OF SIOP MODEL ON TITLE I STUDENTS' NUMBER SENSE

6.NS.C.6 Ordering rational numbers on a number line, determining location on a coordinate plane.
These graphs model the strong positive correlation for the standards. If the correlation were very strong the points would appear to be more linear with less outliers.

The standard that showed a moderate positive relationship was 6.NS.B.2: Fluently divide multi-digit numbers using the standard algorithm (Grade 6 CCSS, 2017). As the graph depicts (seen below), the correlation is not as strong and the points are more scattered, but the linear relationship is still visible. The Pearson R Correlation was $r= 0.34$. 
EFFECTS OF SIOP MODEL ON TITLE I STUDENTS’ NUMBER SENSE
The three standards that showed a weak positive correlation were 6.NS.B3: Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation, 6.NS.C.7: Understand ordering and absolute value of rational numbers, and 6.NS.C.8: Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate (Grade 6 CCSS, 2017). The Pearson R Correlation for these standards were; 6.NS.B.3, r=0.21, 6.NS.C.7, r= 0.25 and 6.NS.C.8, r= 0.23. The graphs below show the correlation...
EFFECTS OF SIOP MODEL ON TITLE I STUDENTS’ NUMBER SENSE
The standards that showed no relationship or no correlation were 6.NS.A.1: Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem, and 6.NS.C.5: Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation (Grade 6 CCSS, 2017). Standard 6.NS.A.1 had a Pearson R Correlation of $r = -0.18$ and the standard 6.NS.C.5 had a Pearson R Correlation of $r = 0.15$. The following graphs represent this relationship…
This correlational study was done using the SIOP Model for lesson planning and instruction for seventeen, sixth grade Title I students. The goal was to determine if the SIOP model was effective for Title I students as well as English Language Learners. Based on the data, there is a weak or no correlation between the effect of the SIOP model and Title I, sixth grade students’ mathematical number sense.
Chapter 5 - Discussions and Conclusions

One reason as to why the data was varied was because the Common Core State Standards (CCSS) vary in complexity. Some are more computational and don’t require much in the way of academic vocabulary. There has been an area of concern in mathematical language among English Language Learners (ELLs) (Gamez, Levine, 2013) and a correlation between low-socioeconomic (SES) students and mathematical achievement, confidence and interest (Yang, Lai, Yao, Huang, 2014). Studies also have shown that students with mathematical difficulties in the area of problem solving showed the most improvement under the testing conditions, which were verbal and visual instruction (Swanson, Orosco, & Lussier, 2014). Research has shown that an emphasis on language while teaching mathematics has been essential and teacher-training programs need to implement these strategies into their training programs (Chval, Pinnow, Thomas, 2015). Thus the process or rules need to be taught for mathematical computation.

In standards that had a higher demand on understanding academic vocabulary (i.e. rational numbers, coordinate plane, x-axis, y-axis, ordered pair, quadrants, scale, integer, etc.) there was a strong correlation. This would imply that the sheltered instruction observation protocol (SIOP) model was effective for these standards.

Standards that require more computation and less academic vocabulary had a weak correlation implying that the SIOP model was not effective. In this instance another lesson strategy would be suggested.

Other variables that may have contributed to this data were the participants’ daily attendance, note taking ability and previous mathematical gaps. The student attendance would impact test scores if they happened to be absent on a day where a
new concept was introduced. Attendance was not part of this study. Additionally, students were asked to take notes at this level, but there is no formal structure as to how these notes were taken. Some students took more detailed notes than others. Some couldn’t tell you what their own notes mean. Since the CCSS has a degree of vertical alignment, it is possible that a student may have gaps that were formed prior to this experiment making the process that much more difficult to grasp.

Based on the data I would say that this was a Null Hypothesis. There is a weak to no relationship between the effect of the SIOP model and Title I, sixth grade students’ mathematical number sense. Since there were cases that there was a correlation, the SIOP Model could be effective for topics with a lot of vocabulary and less computation.

The sample size in this study was very small, in the future the principal investigator would use a much larger sample size and possibly compare the results against non-Title I students. Additionally, the study should involve the standards that require a stronger vocabulary, such as the Expressions and Equations Standards, instead of the Number System standards, since they were mainly computational in nature.
References


http://www.corestandards.org/Math/Content/6/NS/

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Appendix

Pearson's r Correlation (modified from Instructor's Resource Guide for the Text)

The concept of correlation is first introduced in Chapter Three. When working with regional data files (GLOBAL, AFRICA, ASIA, EUROPE, LATTIN, and NAF-SAS), the following guidelines for interpreting positive or negative correlations (Pearson's r) may be helpful. These are only crude estimates for interpreting strengths of correlations:

If r = +.70 or higher Very strong positive relationship
+.40 to +.69 Strong positive relationship
+.30 to +.39 Moderate positive relationship
+.20 to +.29 weak positive relationship
+.10 to +.19 No or negligible relationship
-.01 to -.19 No or negligible relationship
-.20 to -.29 weak negative relationship
-.30 to -.39 Moderate negative relationship
-.40 to -.69 Strong negative relationship
-.70 or higher Very strong negative relationship

Cramer's V Correlation (modified from Instructor's Resource Guide for the Text)

The concept of correlations using survey data is first introduced in Chapter Six. When working with survey data files (any file beginning with the prefix WVS), you can use the following guidelines for interpreting Cramer's V correlations. Again, these are only crude estimates for interpreting strengths of correlations:

If Cramer's V = .25 or higher Very strong relationship
.15 to .25 Strong relationship
.11 to .15 Moderate relationship
.06 to .10 weak relationship
.01 to .05 No or negligible relationship

Significance — What it means

A statistically significant finding is one that is determined (statistically) to be very unlikely to happen by chance. Statisticians are able to calculate the likelihood that any observed relationship between two variables (as indicated by any number of cases) could have happened by chance (or random variation). If it is calculated that there is less than a one in twenty chance (.05 or 5%) that the observed relationship could have happened by chance, the findings are designated as significant. If there is less than a one in one hundred chance (.01 or 1%), they are designated as highly significant. Significance is influenced by the number of cases in your sample, and the observed range (difference) of the sample. Simply put, you're more likely to be sure the differences you observe from a sample are accurate for the whole population if there are many cases and large comparative differences in the observed relationship between a specific set of variables. This text indicates significance by placing one or two asterisks (*) after the Pearson's r, or Cramer's V. In cross-tabulation, using the "Statistics" view, you can see Cramer's V on the second line, and the Prob. on the first line. If Prob. is less than 0.05, your data is significant. See pages 91-93 in the text for further explanation.

http://faculty.ucr.edu/keleibol/sociology/Statistics.html