Effect of supplemental instruction on student success

by

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ABSTRACT

Supplemental instruction (SI) was developed in the late 1970s but many institutions still do not realize academic benefits of this program. The analysis of the data collected at a large public research university in the Midwest, demonstrated that the final course grade for all three courses is higher for SI-participants than for non-participants. At the same time, the SI participants on average have lower ACT score than the non-participants. Moreover, the final course grade positively correlates with the number of SI sessions attended meaning that the more SI sessions the students attend the higher grade they receive for the course.

Keywords: Supplemental Instruction (SI), SI participants, non-participants, final grade, ACT
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CHAPTER 1
THE PROBLEM AND ITS UNDERLYING FRAMEWORK

Supplemental instruction (SI) has been in existence in the USA since the late 1970s but many institutions still do not realize academic benefits for students from this program. First of all, the SI program can be one of the solutions for the problem of poor academic performance of some students. In 1981 the U.S. Department of Education designated SI Exemplary Education Program, based on the finding that SI is one of two programs that improve student academic achievement. Webster and Dee (1997) found that students who ever attended SI receive significantly higher course grades than students who never attended SI and that students who attend SI are less likely to receive a final course grade of D or F. Webster and Hooper (1998) showed that the percentile of the students who earn A and B grades is considerably higher among SI participants than the same percentile among non-participants.

Second, SI can be an effective approach for enhancing student retention. Performing research on the impact of supplemental instruction, Hensen and Shelly (2003) concluded that “student affairs professionals looking for a “new” retention initiative may find SI to be an economical and effective approach to ensure that students are successful during the most crucial phases of their college development” (p. 258).

At last, the SI program provides an opportunity to utilize the well known heterogeneity of student abilities rather than to consider it an obstacle. Indeed, one of the key elements of the SI program is that SI Leaders, undergraduate students who have previously taken the course and demonstrated academic competency in the subject area, assist other students in acquiring the course material and improving study skills.
This study is devoted to investigation of effectiveness of SI programs for three foundational science courses, biology, chemistry, and mathematics, at a large public research university in the Midwest.

**Background of the Problem**

There are several traditional support mechanisms to assist students in difficult classes: course specific tutorials, one-to-one tutoring and instructor office hours. However, in some cases this seems to be not enough. Frequently, students are not attending regularly scheduled course tutorials, except perhaps just prior to an exam when a single tutorial is already inadequate for most of them. Researchers note that many students view the one-to-one tutoring programs as remedial type of assistance and as a result, students who may have benefited from tutoring are reluctant to access such a program. Instructor office hours are also not used by all students because some of them hesitate in seeking help from the instructor for fear of appearing inept. To address the disadvantages of these traditional approaches, Supplemental Instruction (SI) was developed. SI consists of free, regularly scheduled study sessions facilitated by SI Leaders. SI Leaders are undergraduate students who have previously taken the course and demonstrated academic competency in the subject area (Arendale, 1994).

SI as an approach has many advantages. First, SI leaders attend all classes for the targeted course. Both the SI leader and the student are hearing the same lecture, creating an immediate point of reference for the students and SI leader. Furthermore, the SI leader is able to clarify what was said in the lecture, thus avoiding the common pitfall of student misconceptions about what occurred in the lecture. The leader is able to draw on his/her knowledge of the objectives of the course creating an ideal learning environment for students
attending the SI sessions as they strive for success. Second, SI is not remedial. It is viewed as a means to improve student achievement in historically difficult courses. Whereas some of the students attending the sessions may be underachievers or under-prepared, internal motivation is an integral component of students who participate in the SI program. Thus, SI is designed to provide a high-degree of student interaction and mutual support.

Following success of the University of Missouri-Kansas City (UMKC), the extensive doctoral institution under study introduced the SI program in 1992. The SI program at this university is continually assessed through the following methods: attendance and participation data, scheduling surveys and end of the semester student evaluations. Some data are available on the university website. Table 1.1 shows the number of students participating in the SI program and the difference in their performance compared to the general ISU student performance. A brief analysis of this table indicates that only a fraction of students choose to participate in the SI program. At the same time, the students attending SI sessions have higher final course grades than the students who do not participate in the SI program although the difference is not very large.
Table 1.1

*Number of Students Participating in the SI Program and the Difference in their Performance Compared to the General University Student Performance*

<table>
<thead>
<tr>
<th>Year</th>
<th>Course Enrollment</th>
<th>SI Participant Status</th>
<th>SI Final Course Grade</th>
<th>Non-SI Final Course Grade</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-2011</td>
<td>26504</td>
<td>SI 7333 (28%)</td>
<td>2.66</td>
<td>2.43</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 19171 (72%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009-2010</td>
<td>25863</td>
<td>SI 6808 (26%)</td>
<td>2.67</td>
<td>2.38</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 19055 (74%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008-2009</td>
<td>25602</td>
<td>SI 6892 (27%)</td>
<td>2.72</td>
<td>2.37</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 18710 (73%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007-2008</td>
<td>22228</td>
<td>SI 5374 (24%)</td>
<td>2.63</td>
<td>2.41</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 16854 (76%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006-2007</td>
<td>18805</td>
<td>SI 4654 (25%)</td>
<td>2.65</td>
<td>2.38</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 14151 (75%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005-2006</td>
<td>15257</td>
<td>SI 4312 (28%)</td>
<td>2.62</td>
<td>2.31</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 10945 (72%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004-2005</td>
<td>13440</td>
<td>SI 4327 (32%)</td>
<td>2.61</td>
<td>2.36</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 9113 (68%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003-2004</td>
<td>16388</td>
<td>SI 5020 (31%)</td>
<td>2.69</td>
<td>2.41</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 11368 (69%)</td>
<td></td>
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</table>

* Significant difference of means at p < .05
Table 1.1

Continued

<table>
<thead>
<tr>
<th>Year</th>
<th>Course</th>
<th>SI Participant</th>
<th>SI Final</th>
<th>Non-SI Final</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enrollment</td>
<td>Status</td>
<td>Course Grade</td>
<td>Course Grade</td>
<td></td>
</tr>
<tr>
<td>2002-2003</td>
<td>18147</td>
<td>SI 5046 (28%)</td>
<td>2.61</td>
<td>2.31</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 13101 (72%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001-2002</td>
<td>16832</td>
<td>SI 4318 (26%)</td>
<td>2.63</td>
<td>2.39</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 12514 (74%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000-2001</td>
<td>11786</td>
<td>SI 3718 (32%)</td>
<td>2.50</td>
<td>2.29</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 8070 (68%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999-2000</td>
<td>8768</td>
<td>SI 2909 (33%)</td>
<td>2.55</td>
<td>2.11</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 5859 (67%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998-1999</td>
<td>11964</td>
<td>SI 2132 (18%)</td>
<td>2.57</td>
<td>2.26</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 9832 (82%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997-1998</td>
<td>7432</td>
<td>SI 1615 (22%)</td>
<td>2.39</td>
<td>2.23</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 5817 (78%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996-1997</td>
<td>6596</td>
<td>SI 1325 (20%)</td>
<td>2.55</td>
<td>2.31</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non 5271 (80%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant difference of means at p< .05
History of SI Program

SI was developed by Deanna Martin, at the University of Missouri at Kansas City in 1973. At the time, the UMKC faced significant changes in demographics of students and a sudden rise in student attrition rates. The transition from a small, private university (the University of Kansas City) to a large public university that acquired a number of professional schools led to the change in patterns of student access to the university. This change posed difficulties for the faculty who had been used to teaching the top 20 percent of high school graduates. The attrition rate rose from 20 to 45 percent among entering students.

Deanna Martin, then a graduate student, was offered an assistantship to develop a program to improve the retention rate of the new diverse population of students. Her idea was to utilize peer-assisted study sessions to enhance student performance and retention. The first SI program was designed for health science schools. The SI aimed to improve students’ grades in traditionally difficult courses (for instance, math, physics or chemistry) and, thus, to reduce the attrition rate in those courses. SI was also supposed to help students in developing study strategies for the future courses. The goals of the program included reducing attrition “without lowering academic standards or inflating grades” (Widmar, 1994, p. 4).

SI Program Description

From the time of its origination, SI targets high-risk classes that have a number of common characteristics. Firstly, students in these courses are assigned a lot of weekly readings from difficult textbooks and secondary library reference sources. Secondly, examinations are infrequent and “focus on higher cognitive levels of Bloom’s taxonomy”.

Thirdly, attendance in these classes is often either voluntary or unrecorded. And, at last, these classes are often large, and students have little opportunity for interaction with the professor and other students (Martin and Arendale, 1994, pp. 11 – 12). Thus, SI is often associated with traditionally difficult, high-risk entry level courses although it has demonstrated positive results in various fields and at different levels including graduate and professional schools.

Arendale (1994) noted that institutions may come up with their own definitions of high-risk courses. At the same time, he bases his vision of a traditionally difficult or high-risk course on a definition developed in the work of Martin, Lorton, Blanc, and Evans (1977) that states that traditionally difficult academic courses are “those that typically have 30 percent or higher rate of D or F final course grades or withdrawals” (p. 11).

An important feature of SI emphasized by its founders and The International Center for Supplemental Instruction is its proactive nature. SI sessions begin the first weeks of classes and assist students in preparation for their first tests and examinations. Thus, the SI model is a unique proactive academic support program targeting difficult courses rather than high-risk students. This program is voluntary and it should not be viewed as remedial, as it is open to all students enrolled in the targeted course.

A key figure of the SI program is a peer student leader, called an SI Leader, who is hired and trained to facilitate regularly scheduled study sessions to assist students with course content and study skills. The SI leader attends lectures regularly and plans three to five 50-minute sessions structured review sessions each week. His/her duty is not to re-produce the attended class to the students, but rather to use collaborative learning tools to assist students.
The foundation and theoretical framework for SI is based on student development theory, cognitive development models, learning collaboration methods, and retention research. Astin (1987) found that collaborative approaches to learning help solve the problems of large classes and differences in student preparation. He also noted the advantage of cost-effectiveness of these approaches.

Astin (1985) introduced his involvement theory, a theory of student learning and development, as part of his talent development approach. He was first to formulate a new, developmental approach to institutional excellence. According to his view, “an excellent institution is one that facilitates maximum growth among its students and faculty” (p. xiii). Astin developed the involvement theory to assist institutions in achieving their talent development goals. Involvement, according to the author, “refers to the quality and quantity of the physical and psychological energy that the student invests in the college experience” (p. xiv). This theory argues that the effectiveness of educational policies and practices aimed at developing students’ talents depends on how well these policies and practices can improve student involvement. In this study, student participation in learning communities and SI programs are viewed as involvement.

Deanna Martin who developed the original SI model in 1970s based her work on contemporary perspectives on cognitive development, student development, and the emerging collaborative learning pedagogy (Arendale, 1994). The theoretical foundation of her model derived from the achievements of Piaget, Vygotsky, Dale, Tinto, Weinstein, Keimig, and experience of peer group study sessions (Johnston & Johnston, 1989; Light, 1990). At the same time, more recent research and perspectives on student development and
retention (Astin, 1987; Pascarella & Terenzini, 1991; Tinto, 1993; Upcraft & Gardner, 1989) also support the SI model.

**Purpose and Research Questions**

The purpose of the study is to investigate the effect of taking Supplemental Instruction on students’ academic performance. The study employs existing data collected by two university units, the Registrar’s Office, and the Academic Success Center. The coded data are analyzed with the help of the statistical software, Stata.

The study population includes adult students who took Biology 211, Chemistry 177, and Math 165 during academic years of 2006-2007, 2007-2008, 2008-2009, and 2009-2010 with the sample size being 11,809 (consisting of 4,028 from Biology 211, 3,435 from Chemistry 177, and 4,275 from Math 165). These classes are foundational science courses required for many science and engineering majors. In other words, they are foundational courses for the main body of students at our large public university. At the same time, these courses are categorized high risk or difficult in terms of student retention, have large classes and historically request Supplemental Instruction on a regular basis.

The present study focuses on the following research questions:

1. What are the distributions of SI participants’ gender, ethnicity, ACT score, and high school percentile rank compared to those students who do not attend SI sessions?

2. What variables best predict the final grade in the course?

3. What is the effect of the number of SI sessions on course final grade?

4. Does the effect of SI vary by course?
**Hypotheses**

To address the first research question, the following hypotheses are tested:

1.1. There is no difference in gender composition between participants and non-participants of the SI program.

1.2. There is no difference in ethnic composition between participants and non-participants of the SI program.

1.3. There is no difference in average ACT score between SI participants and non-participants.

1.4. There is no difference in average high school rank between participants and non-participants of the SI program.

To address the second research question, the following hypothesis is tested:

2. The ACT score, high school rank, and demographics are not the best predictors of the course final grade.

To address the third research question, the following hypothesis is tested:

3. The course final grade is not correlated with the number of the SI sessions attended.

To address the fourth research question, the following hypothesis is tested:

4. There is no difference in the effect of the SI program for different.

**Significance of the Problem**

Recent economic hardships have resulted in numerous institutional budget cuts eliminating programs, and whole departments, and increasing numbers of students in one classroom. Together with the public demands of accountability, financial difficulties pose a serious challenge for higher education institutions to teach with fewer resources more students more effectively. The Midwestern university under study is no exception.
Supplemental Instruction is one of the academic support programs developed to assist students to succeed in historically difficult courses. It was originally designed for big science classes, and has shown fruitful results both on undergraduate and graduate levels (Martin and Arendale, 1994). Nowadays, the increased demand and use of Supplemental Instruction call for more studies of its effectiveness in current institutional contexts. In addition, self-selecting nature of Supplemental Instruction and problematic use of experimental design pose questions of credibility and indicate the need in implementing new methods to investigate its results.

The results of this study can be used by the university Academic Success Center that administers student support programs, other student affairs professionals, faculty, and university administration who are interested in that students succeed academically and that the institution uses cost-effective means to assist students in achieving their academic goals.

**Definition of Terms**

The International Center for Supplemental Instruction (2012) gives the following definition of SI.

Supplemental Instruction (SI) is an academic assistance program that utilizes peer-assisted study sessions. SI sessions are regularly-scheduled, informal review sessions in which students compare notes, discuss readings, develop organizational tools, and predict test items. Students learn how to integrate course content and study skills while working together. The sessions are facilitated by “SI leaders”, students who have previously done well in the course and who attend all class lectures, take notes, and act as model students. (para.1)
The SI Program targets traditionally difficult courses. A “difficult course” typically has a high percentage of students who earn D or F grades or drop out of the course. However, SI does not specifically target students who are high-risk students; SI is not a remedial academic program. SI provides an opportunity for students to learn how-to-learn while learning what-to-learn and focuses on both course content and study skills.

SI Leaders are students who are hired to facilitate SI sessions based on their knowledge of the course, ability to lead large groups, and faculty recommendations. SI Leaders take a special training. They attend the course classes along with the students and then prepare session activities based on material covered in lectures and on students’ requests.

SI Participant is a student enrolled in a course offering SI who attends at least five SI sessions during the semester. At the university under study participation in SI is voluntary, free-of-charge, and open to all students in the course.

SI session lasts 50 minutes and provides an opportunity for students to work together to explore important concepts, review class notes, discuss reading assignments, practice test-taking strategies, and prepare for examinations. It is peer-facilitated by a SI Leader, an undergraduate student who has previously been successful in the targeted or related course.

**Organization of the Study**

The reminder of this study is organized as follows. Chapter 2 provides a review of relevant research on SI. Chapter 3 describes the research design used in this study, including data analysis procedures and methodological limitations of the study. Chapter 4 presents the research findings. First, the results of the descriptive statistics on the attendance of SI sessions are presented. Second, the effect of SI sessions on the final course grade is
discussed using the multivariate regression analysis. Finally, Chapter 5 presents discussion of the main results, implications for practice, and recommendations for future studies.
CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

This chapter provides a review of the literature on SI. As was noted in Chapter 1, Supplemental Instruction has been in existence in the USA since the late 1970s. It is not surprising that different aspects of this model have been objects of a lot of research. The studies devoted to SI programs can be divided into five categories: descriptions of SI programs, programs that have been developed based on SI experience, SI programs abroad, SI achievements, and input in improving teaching, and effectiveness of SI programs in various fields and institutions.

The first section of this chapter is devoted to descriptions of SI programs, their goals, and peculiarities. The second section reviews modifications of the SI program. The third section is devoted to SI programs abroad, in particular, in the UK, Canada, and South Africa. The fourth section describes some SI achievements and input in improving teaching. The effect of the gender difference on attending SI sessions is specifically mentioned. At last, the fifth section is devoted to studies on SI effectiveness. Special attention was paid to factors that should be taken into account in consideration of SI effectiveness. This determined the choice of variables used in the statistical analyses performed in the present study.

Documentation

Two main sources were used to search for the relevant literature about SI. First, the University of Missouri-Kansas City (UMKC) where the SI program was originally developed keeps collecting information on scientific articles devoted to SI. The list can be found at http://www.umkc.edu/cad/si/index.shtml. Second, Web of Knowledge allows finding
relevant articles about SI. The following approach was used. The initial search was done using “Supplemental Instruction” as topic which allowed obtaining the first articles. Then, other articles of found authors were reviewed. Finally, the articles that were cited in the first group of sources and the articles that cited the found articles were reviewed.

**What is SI?**

SI is an academic support program aimed at enhancing student performance and retention with the help of collaborative learning strategies implemented at regularly scheduled study sessions facilitated by trained undergraduate students (Widmar, 1994). Blanc, DeBurh and Martin (1983) noted the importance of the fact that the SI program is proactive rather than reactive. Because SI schedules are set at the beginning of semester, it gives students opportunity to obtain assistance before they encounter serious academic difficulty. Blanc et al. also considered very important that SI leaders should attend each class meeting rather than provide instruction based upon the students' perceptions of what occurred in class. Because these perceptions are often badly distorted, students do not get the kind of assistance they need.

Interestingly, according to Blanc et al.’s research, the first students who participate in the SI program are usually those who tend to be better prepared academically. This encourages participation from less able students who often find it difficult to admit that they need assistance. The SI program also gives a course instructor an opportunity to receive useful feedback about the problems students encounter. The point is that students generally hesitate to be candid about academic concerns to course instructors for fear of demeaning themselves. They will, however, openly acknowledge their problems to the resource person
whose duty is to assist in such matters, and whose responsibility does not include assessment of students' course performance.

Simpson, Hynd, Nist and Burrell (1997) thoroughly examined various academic assistance programs and their instructional methods from the perspective supporting self-regulated learning. Categorizing various academic assistance programs, the authors took into account several factors. These factors included program goals, viewpoints, placement and assessment procedures, salient program features (e.g. methodology), and program evaluation procedures. They placed all programs along a continuum with one end being the programs for improving students’ functional reading skills, and the other end being the programs for developing students’ learning strategies. The researchers noted, however, that most of existing academic support programs could be places “along this continuum rather than at either extreme” (p. 41).

Simpson et al. (1997) distinguished four critical issues confronting academic assistance programs. The first issue is whether a program is based on a generic or embedded approach. Generic approaches, according to the authors, involve teaching general reading or cognitive skills separate from a specific subject area. The embedded approach, on the other hand, consists in teaching learning strategies within a specific content area (p.42). The authors themselves believe that “self-regulated learning should be taught within a realistic context and a content area” (p.43).

The second critical issue confronting academic assistance programs, according to Simpson et al., is the transfer of strategies acquired in the programs to other content areas. The third issue concerns the role of task and context. And the fourth issue consists in the role of motivation. The authors noted the novelty of research on the motivational aspects of self-
regulated learning. They believed that “students’ “will” is as important as their “skill”” (p. 45).

Reviewing Supplemental Instruction, the researchers considered the program and its modifications with regard to the aforementioned critical issues of academic assistance programs. They classified SI as an embedded curriculum model which they see as both the root of the program’s success and its major drawback. In their view, the narrow focus on one content area and one professor requirements for the course hinders further transfer, modification, and applicability of strategies learned at SI sessions. At the same time, the researchers noted one of the major advantages of the SI model, that it targets high-risk courses, not at-risk students. However, they believed that preparation and facilitation of SI sessions are labor intensive for SI Leaders or instructors.

In the overview of research and evaluation available on Supplemental Instruction, Simpson et al. mentioned positive results obtained by numerous evaluation studies of SI. However, they also expressed a concern with the self-selection bias in evaluation of SI programs. Because in most SI programs, student attendance is voluntary, their participants are more likely to be persons more motivated and open to learning new strategies than those who choose not to be involved. To support their argument, they referred to the study by Visor, Johnson, and Cole (1992) who found that regular SI participants possessed internal locus of control and greater feeling of self-efficacy and self-esteem than non-SI participants (Simpson et al., 1997, p. 54).

For future research, the authors suggested addressing the problem of self-selection bias, conducting longitudinal studies, and synthesizing the SI research. They concluded their description of the theory and research most relevant to academic assistance programs with
recommendations to college students interested in academic assistance along with suggestions for future studies to researchers.

**SI Modifications**

To meet the needs of different institutions and student populations, variations of SI have emerged over the years. One of the first modifications of the original SI model, the Video Supplemental Instruction model (VSI), was developed at the Center for SI at the University of Missouri Kansas City (Martin & Blanc, 1994). The VSI aimed at assisting academically underprepared students. The use of a videotaped lecture provided many advantages including student control over the rate of the flow of information, opportunity for deeper comprehension, and direct integration of study skills and content. Thus, the purpose of one of the first modifications of the SI model was to assist at-risk students utilizing modern for the time technological advancements. Reaching for at-risk, academically marginalized students became the main goal of many SI versions in the U.S. and abroad.

Commander and Smith (1995) from Georgia State University (Atlanta, GA) presented an adjunct course model, a variation of the Supplemental Instruction program to provide more time for developmental students to enhance reading and learning strategies. According to their definition, “adjunct courses are taught generally in conjunction with college content courses such as history, political science, psychology, or biology” offering reading and learning strategies to students registered for credit in those content courses (p. 353). The proposed at Georgia State University adjunct course model varied from the SI model in course pairing and population served. Initially, one adjunct course was paired with all sections of the high risk course. However, based on the results of their pilot courses, the authors recommended pairing an adjunct course with one specific section.
In terms of the differences in populations served, the GSU adjunct course model was designed for developmental students who otherwise would not have been able to enroll in the content course (History 113, in their case). The students were identified as high risk, and required to take a course in reading. This information, however, was not provided to the history professors. Another difference of the adjunct course from the SI model was that the instructors in the learning strategies courses did not attend content course classes simultaneously with teaching their course. They had attended the classes prior to the beginning the adjunct course. In addition, the learning strategies classes required students to apply the learning strategies to the companion History 113 course.

Considering that the participants were less prepared academically than the general student population in the History 113 course, data suggest that the adjunct course was helpful since three quarters of the students passed the History 113 course with a final course grade of C or higher and their mean final course grade (2.3) with nearly the same as the other students (2.5).

The recommendations for potential adopters of this model included pairing of the course with only one section of a high risk course; apart from teaching learning strategies, developing metacognitive awareness, and focusing on the structure of the discipline. Commander and Smith also found the use of daily grading an effective means to motivate learners.

Hurley, Mckay, Scott And James (2003) described a student-run Supplemental Instruction Project (SIP) that was developed and delivered by second-year medical students and offered free of charge to all first-year medical students at Memorial University of Newfoundland in 1999 and again in 2000. Small-group tutorials focused on subject material
that second-year medical students identified as ‘difficult’. Five 60- to 90-minute sessions covering topics in cardiology, nephrology and respirology were offered. Post-session quiz scores were significantly greater than pre-session scores. Student and tutor perceptions of SIP were positive. The researchers concluded that the SIP is an acceptable, practical and effective method to supplement delivery of challenging material to first-year medical students.

**International SI Programs**

At the present moment, the SI approach is used not only in the U.S. universities but also abroad. Jenkins (1994) described thirteen strategies for geography instructors in the United Kingdom to consider in order to increase instructional effectiveness in large classes. The author noted that while the use of postgraduate students to perform certain aspects of field supervision is well established this strategy could be extended to upper level students supporting first- and second-year students on project-based fieldwork. The researcher mentioned cost effectiveness of a program where student “helpers” assist other students. As the best developed example of this strategy the authors refer to Supplemental Instruction.

Saunders (1992) described peer tutoring programs at higher education institutions in the United Kingdom. Supplemental Instruction (SI) is one of these programs. The author noted that in the UK, lecturers are being asked to experiment with a greater variety of teaching and learning strategies which complement the lecture tradition. As an example of a program that can complement the traditional method, the researcher mentioned SI and described the SI program at Kingston Polytechnic.

Topping (1996) studied quality, outcomes and cost-effectiveness of methods of teaching and learning in colleges. Through an extensive review of the literature, the author
discussed peer tutoring in general with a short review of the Supplemental Instruction program. The author mentioned research studies from both the USA and UK noting that participation in SI positively correlated with higher mean final course grades. According to the researcher, other UK studies suggested improved communication skills and deeper understanding of the curriculum for SI participants and higher grades for the SI Leaders themselves.

Eastmond, Bartlett and Terblanche (1997) described the use of SI at Border Technikon (South Africa). The SI program at Border Technikon is offered to increase student achievement in the academic departments of Accounting and Management. It was originally funded from a grant provided through the United States Agency for International Development (USAID) Tertiary Education Linkages Project (TELP). The authors mentioned that the grant's major goals were to enhance staff and student development, both of which were achieved through the SI program.

According to Eastmond et al.’s research, all participants of the program (students and SI Leaders) benefited from SI. SI Leaders reported that they had improved confidence in public speaking, developed new teaching strategies; and enjoyed more interaction with the course lecturers. After the introduction of the SI program, the number and percentage of students who passed the final examination doubled. The authors found this achievement remarkable considering that the class size had increased significantly.

Fayowski and MacMillan (2008) presented a study of the effectiveness of a SI program in mathematics at a small Canadian university. Their program was paired with a first year calculus course for non-majors. The authors were concerned with the common for SI research selection bias due to ability/motivation and gender which they aimed to address.
They chose as a measure of ability/motivation prior grade point average that proved to be a useful predictor of course grade. In their study, gender differences were statistically significant favoring women but trivial. Controlling for selection bias and gender, they discovered that with SI participation there was 1.8 letter grade improvements. It is important to note that their cut point of SI participation was attendance of at least five sessions. Fayowski and MacMillan (2008) chose the cut point of five sessions because of good fit with natural breaks in the data and their belief that “a student could not possibly be expected to display benefits of SI with lower numbers of sessions” (p. 849). Thus, Fayowski and MacMillan’s study along with many others presented evidence of SI effectiveness beyond the USA; however, their choice of only one variable accounting for selection bias may not be sufficient.

**SI Achievements and Input in Improving Teaching**

Lundeberg and Moch (1995) explored the use of Supplemental Instruction (SI) for increasing academic success of women in science. They noted that many women prefer the connected knowing learning style which is a personal, cooperative approach to learning, where values tie theory to experiences and which stresses belief rather than doubt. According to the authors, this style can be more naturally realized in SI sessions rather than the traditional pedagogical style used by most classroom professors.

A research study of nursing students at the University of Wisconsin (River Falls) was conducted to test this idea. Qualitative research studies of the SI sessions suggested the following themes: spirit of cooperation, a circle of community, a shift of power to the SI participants, and risk-taking behavior (acknowledge uncertainty, experiment new ideas without fear of lower grades or punishment). Cognitive learning aspects included confirming
the capacity for learning (encouragement), calibrated teaching (SI leader adjusted SI session agenda), and connected learning (placing abstract class lectures into context of personal lives). The authors provide several suggestions on how the classroom professor can introduce several of the SI session activities into their lecture sessions.

**SI Effectiveness**

Hensen and Shelley (2003) conducted a longitudinal study on the effect of SI on retention at a large Midwestern university. Their research focused on entry-level biology, chemistry, mathematics, and physics. They found that SI participants earned a significantly higher percentage of A and B grades, earned a significantly lower percentage of Ds, Fs, and withdrawals, and had significantly higher mean final course grades than non-SI participants.

Marra and Litzinger (1997) formulated three fundamental questions about the SI program that researchers of SI need to address. First, what type of student is attending the SI sessions? Is this a student who really needs help from SI sessions, or is this someone who would tend to perform well anyway? Second, do the students who attend SI sessions earn higher final grades than the students who do not attend SI sessions? Finally, do the students who attend SI sessions use the strategies they learned in their SI supported courses in subsequent courses?

Webster and Dee (1997) studied the effect of the SI program in introductory engineering courses. They found that students who ever attended SI received significantly higher course grades than did students who never attended SI and that students who attended SI were less likely to receive a final course grade of D or F, and were less likely to withdraw from the engineering program. However, according to their study, approximately half of the
students who could really benefit from attending the SI program (including so called “high-risk” students) chose not to attend SI program, even when encouraged to do so.

Webster and Hooper (1998) studied the effect of the SI program on the students’ performance in introductory chemistry courses. Their data analysis showed that the percentage of students who earn A and B is considerably higher among SI participants than among SI non-participants. At the same time, the percentage of withdrawals is much higher among the SI non-participants than among SI participants.

Congos and Schoeps (1993) published an analysis of the data on utilizing the SI program at the University of North Carolina at Charlotte from 1987 to 1990. Their results indicate that students attending SI sessions earn higher final grade averages and receive fewer low grades and withdrawals than non-attendees. Their favorable results were such in spite of the fact that the two groups did not significantly differ in entrance level academic potential and indicators of industriousness (SAT and high school rank variables). However, when the SAT scores were significantly different, the non-participants had higher grades.

In their study, Congos and Schoeps mentioned the problem of self selection bias that complicates analysis of SI effectiveness. Their solution to this problem was the choice of students with similar pre-entry characteristics which included SAT scores and high school rank.

Regarding implementation of a SI program, the authors noted that it is not a complicated venture and that, administratively, SI easily fits into existing learning assistance programs. They believe that the SI model is simple to grasp and should be quickly mastered by administrators, supervisors and undergraduate SI leaders. The SI goal of creating independent self-educators is one which most institutions will embrace. In their view, the
program should also attract the support of hard-working faculty members. At the same time, as the research indicates, students who participate in SI are more likely to re-enroll in subsequent semesters and are more likely to graduate. Congos and Schoeps believe that, in this light, administrators should be more willing to commit financial resources.

Shaya, Petty and Petty (1993) studied the effects of SI in Basic Biology I course at Wayne State University (MI). The SI sessions were open to all students in the course. Of the entire student population, 25% of students attended the optional supplemental instruction, whereas 40% of the excel students attended supplemental-instruction sessions by the end of the semester. Their data suggested that SI contributed to higher mean final course grades for SI participants (2.9) vs. nonparticipants (2.4). Shaya et al. conducted a separate analysis to compare the academic performance of at-risk students. At-risk SI participants (low high school grade-point average, low ACT standardized test scores) received higher mean final course grades (2.65 vs. 1.31) and had a higher course completion rate (90 percent vs. 32 percent). They made an attempt to control for student motivation level, and conducted an analysis of high school grade point averages and ACT scores for SI and non-SI participants among the at-risk students. The researchers did not find any significant differences. Their second analysis for student motivation considered intrasemester SI entry. At-risk students who began to attend SI later in the academic term earned higher mean final course grades than at-risk students who chose not to attend SI. Shaya et al.’s data suggested that SI participation contributed to the majority of the variance concerning higher mean final course grades.

Wolfe (1987) described implementation of the Supplemental Instruction at Anne Arundel Community College in Arnold, Maryland. A Fall 1986 research study concerning
the impact of the SI program with a History 211 course suggested that SI participation contributed to higher final course grades (2.5 vs. 1.6) and lower rates of D, F and withdrawal (16% vs. 55%) even though the SI participants had a lower mean SAT score. SI participants self-reported high satisfaction with their experience in the SI program (4.5 on a 5 point scale). Some professors at the college reported using the SI program for faculty development in the following ways: sometimes the course instructor incorporated SI Leader’s developed materials initially used during SI sessions; used the SI Leader as a feedback forum for evaluating the comprehension level of students of key concepts.

Forester, Thomas and Mcwhorter (2004) studied the effects of SI on students’ learning of Gross Anatomy. First-year medical students received the four supplemental instruction programs (Experimental Group). The Control Group consisted of first-year medical students from the graduating class of 2005 who did not receive the four supplemental learning methods. The authors used Mann-Whitney rank sum tests to compare the two groups’ median percentages of a gross anatomy laboratory practical. The Experimental Group’s median percentages were significantly greater than that of the Control Group. Results from a post-hoc student survey showed that more students both rated and ranked the weekly instructor laboratory reviews as extremely useful and most beneficial. A greater number of students rated and ranked the web-based anatomy program as not useful and least beneficial. The results from this study suggest that the four supplemental instruction programs improved students’ learning of gross anatomy as measured by laboratory practical performance. In addition, students most valued the additional time in the gross anatomy laboratory with the instructors.
Conclusions

Thus, SI is an academic support program that aims at enhancing student performance and retention with the help of collaborative learning strategies implemented at regularly scheduled study sessions facilitated by trained undergraduate students (Widmar, 1994). It is very important that SI sessions start at the beginning of the semester and SI Leaders attend each class meeting to provide informed timely assistance to students. Whereas SI is available for all students and was originally intended for high-risk courses, the programs designed based on this model also help to solve the problem of underprepared students. In order to meet the needs of different educational institutions and student populations, there have been developed modifications of the SI model. This model has been successfully implemented and modified at numerous higher education institutions internationally. It has also benefited research on effective teaching of various student populations and in different subject areas. Overall, SI programs have demonstrated positive effect on student performance and retention. The main challenges that the model is still to confront include the transfer of knowledge and skills to other subject areas and the role of student motivation in evaluation of SI programs.

Most studies show that the students attending SI program get higher final course grades than the students who do not attend this program. However, this does not necessarily mean that participation in the SI program alone leads to increase in the final course grade. The issue of self-selection has been brought up and should not be dismissed in evaluation of SI. Research indicates that it is possible that more motivated students participate in the SI program. It is also possible to suppose that this group of students would have had higher final course grades even without the SI program. Thus, to explore the effectiveness of the SI
program several new studies should be conducted. First, it is necessary to find out if there are any differences between SI participants and non-participants. Second, a multivariate regression analysis should be done to isolate the effect of namely SI program from other factors which also affect the course final grade. Finally, it is important to investigate if the effect of the SI program is the same for all courses or the SI program is more effective for some specific classes. The present study aims to address these questions.
CHAPTER 3

RESEARCH METHODOLOGY

Introduction

The purpose of the study is to investigate the effect of taking Supplemental Instruction on students’ academic performance. To address this problem, the present study employs two quantitative methods. First, I use the descriptive statistics analysis focusing on the question of what type of students attends the SI program. Second, I use a multivariate regression analysis focusing on the effect of the number of SI sessions on the course final grade.

This chapter is organized as follows. First, I restate the research questions and proposed hypotheses. Next, I present the research design and the dataset used in the present study. At last, I describe the variables used in the present study and the statistical methods I employed to address the research questions.

Research Questions and Hypotheses

The present study focuses on the following research questions:

1. What are the distributions of SI participants’ gender, ethnicity, ACT score, and high school percentile rank compared to those students who do not attend SI sessions?
2. What variables best predict the final grade in the course?
3. What is the effect of the number of SI sessions on course final grade?
4. Does the effect of SI vary by course?

To address these questions, the following hypotheses are tested:
1.1. There is no difference in gender composition between participants and non-participants of the SI program.

1.2. There is no difference in ethnic composition between participants and non-participants of the SI program.

1.3. There is no difference in average ACT score between SI participants and non-participants.

1.4. There is no difference in average high school rank between participants and non-participants of the SI program.

2. The ACT score, high school rank, and demographics are not the best predictors of the course final grade.

3. The course final grade is not correlated with the number of the SI sessions attended.

4. There is no difference in the effect of the SI program for different courses.

**Research Design**

In order to address the stated research questions, two quantitative methods were used. The first method was descriptive statistics that was mainly used to answer the first research question. The second method was the multivariate regression that was used to answer the second, third, and fourth research questions.

**Population and Sample**

The population of the present study is first and second year full-time students who attend an extensive doctorate university in the Midwest and take science courses. This population includes only students who enrolled at the university directly from high school and hold U.S. citizenship. Thus, this study is interested in a relatively homogeneous group comprising the majority of the university student population.
The sample of this study consists of 11,809 students who were enrolled in entry-level biology, chemistry, and mathematics courses during academic years of 2006-2007, 2007-2008, 2008-2009, and 2009-2010. These courses are foundational science courses required for many STEM (science, technology, engineering, and math) majors. In other words, they are foundational courses for the main body of student at the large public research university under study. At the same time, they are also high risk courses that have large classes and historically request Supplemental Instruction on a regular basis. All of the mentioned above classes had SI sessions offered throughout given semesters. The variables included in this study identify which students prefer to utilize the SI program and explore what additional factors influence the effectiveness of the SI program.

**Instrumentation and Data Collection**

The study employs existing data collected by two units of the university under study, the Registrar’s Office and the Academic Success Center. These data are not available for public use. The Research Analyst of the Registrar’s Office combined needed data from all these units and removed identifiers. After the data were coded and all identifiers were removed, the data set was provided for this study.

A Human Subjects Review form was submitted to the Institutional Review Board of the university under study for permission to perform this research study. Following approval for this study, a request for the demographic and achievement variables was sent to the Office of the Registrar and the Office of Academic Success Center.
Data Analysis

Variables

In the present study, I employed the block entry multivariate regression model to analyze the effect of the SI program on the course final grade. The independent variables in the study comprise three categories – demographic, achievement, and level of SI participation. The demographic variables include: gender (Gender), ethnicity category (EthnicityCat), and learning community participation (LCParticipant). The achievement variables are high school percentile rank (HS_Rank) and ACT composite score (act). At last, the level of SI participation variables include the number of SI sessions attended (tat) and a categorical variable classifying students as SI participants and non-SI participants. For the purposes of this study, SI participants are defined as those students who attended five or more SI sessions. A detailed definition of each variable is provided in the Appendix. However, the dataset used in the present study lacks information on students’ performance in science classes at the high school level, and whether they have been retained at the university at least a year after completing the course under study.

Tinto’s (1993) model of student retention that describes student attrition as the result of inadequate integration into the social and academic systems of the college acknowledges that students come to institutions of higher education with certain pre-entry characteristics. These pre-entry characteristics include academic achievement, high school percentile rank, ethnicity, and gender. According to Tinto, these factors help determine how a student will relate to the college system. And even though, in his model, Tinto stresses the importance of college experiences, he admits that pre-entry characteristics matter for student success. Thus, the inclusion of such variables as gender, ethnicity, ACT composite score, and high school
percentile rank along with the variables signifying a certain level of student involvement in university academic life (participation in SI and learning communities) should give a more accurate picture of what influences students’ course grades.

**Gender and ethnicity.**

The relationship between gender and academic performance has attracted the attention of many researchers. Rauschenberger and Sweeder (2010) studied the performance of students at Michigan State University in a two-part biochemistry series for students enrolled from 1997 to 2009. They found that the students’ cumulative GPA has the primary influence on their biochemistry grade and that the gender of the student was also statistically significant.

de Winter and Dodou (2011) studied the extent to which high school exam scores predict first-year grade point averages and completion of Bachelor of Science programs. They discovered that while women entered university with higher average exam scores than men, gender was not predictive of first-year GPA and was a weak predictor (with an advantage for women) of B.S. completion.

Sonnert and Fox (2012) analyzed gender differences in the undergraduate grade point averages. In particular, they focused on so called ecological hypothesis that postulates that women undergraduates have higher GPAs than do their male counterparts, and this GPA difference is larger when the percentage of women is smaller. The analysis of their data did not confirm the stated ecological hypothesis.

Willoughbya and Matz (2009) investigated the differences in learning gains by gender from the data in large introductory astronomy and biology courses. The researchers found that male astronomy students had significantly higher pre- and post-test scores than
female students on the astronomy diagnostic test. Male students also had significantly higher pretest and somewhat higher post-test scores than female students on a survey instrument designed for an introductory biology course. For both courses, men had higher learning gains than women only when the normalized gain measure was utilized.

Lynch and Trujillo (2010) investigated the motivational beliefs and learning strategies of students in the second semester of organic chemistry. They discovered that student self-efficacy highly correlates with academic performance. In their study, gender differences were quite pronounced. Academic performance of men was associated with intrinsic motivation as well as the importance placed on the learning task. Test anxiety was negatively associated with male grades. Extrinsic motivation was negatively correlated with female grades. Responses to students’ sense of control over learning, the value of the learning task, and self-efficacy were significantly higher for men compared to women. The authors concluded that women could especially profit from focused faculty intervention.

Zwick and Sklar (2005) studied the effect of student ethnicity and first language on grades. They found that the percentage of variance in first-year college GPA jointly explained by high school GPA and SAT score varied from 7% to 20% across groups. They also showed that high school GPA had a statistically significant influence on graduation in the White/English group; SAT had a significant effect in the Hispanic/English and White/English groups demonstrating the value of taking language background into consideration in educational research.

Murtaugh, Bums, and Schuster (1999) studied data on retention of undergraduate students at Oregon State University between 1991 and 1996. They discovered that attrition decreased with increasing high school GPA and first-quarter GPA. According to their
findings, nonresidents have higher attrition rates than resident and international students.

The researchers also noted statistically significant associations of retention with ethnicity/race at first enrollment.

Thus, many researchers found that such demographic characteristics as gender and ethnicity are important variables that may or may not have effect on student performance depending on other key factors of a specific population.

ACT and high school percentile rank.

The effect of the ACT and high school percentile rank on the college GPA was explored by many researchers. Kuncel, Crede, and Thomas (2005) reviewed the literature on the accuracy of self-reported grades, class ranks, and test scores. The results of their study based on a pairwise sample of 60,926 subjects indicated that self-reported grades are less construct valid than many scholars believe. Furthermore, self-reported grade validity was strongly moderated by actual levels of school performance and cognitive ability. These findings suggested that self-reported grades should be used with caution.

Barron and Norman (1992) studied how well students' grades at the University of Pennsylvania could be predicted from linear combinations of high-school class rank (CLR), total scholastic-aptitude-test score (SAT), and average achievement-test score (ACH). Their consideration of multiple regression coefficients revealed that high school percentile rank and average achievement-test score add significantly to overall prediction, whereas SAT did not.

Cheng and Ickes (2009) studied the effect of conscientiousness and self-motivation on the university-level academic performance. They found that conscientiousness and self-motivation compensated for each other in predicting university GPA: Students who were
either high in conscientiousness or high in self-motivation had better academic performance (GPA) than those who were low in both conscientiousness and self-motivation. It is important to note that these findings were still evident after the students' previous academic performance (high school percentile rank) and academic ability (SAT/ACT) were taken into account.

**Learning community participation.**

According to the university under study learning community website, learning community is a term used to describe different approaches that cluster several connected courses with a common interdisciplinary theme. It gives the students an opportunity to contact with other students who have similar academic goals/common courses and in some cases common place of residence adding new options to career exploration and utilizing of the university resources. Some faculty and stuff play an active role in the learning community initiative by serving on committees, collaborating with departments outside of learning communities, and establishing connections between faculty and students at the university. The data reported on the university Learning community website show that the retention rate among the participants of learning communities is higher than among those who do not participate in them.

**Statistical methods**

A linear regression model was used to address research questions 2 through 4. The simplest linear regression model with one regressor postulates a linear relationship between dependent variable Y and independent variable X. This model allows estimating the effect of changing X on Y. The multivariate regression model extends the single variable regression model to include additional variables as repressors. This model allows estimating the effect
of change in variable $X_i$ on $Y$ while all other independent variables are held constant (Stock and Watson, 2007). In the present study, the multivariate regression model allows the isolation of attending SI sessions on the final course grade from the effects of other variables.

The data were analyzed using the general-purpose statistical software package Stata created by StataCorp. This package is used by many businesses and academic institutions around the world. Most of its users work in research, especially in the fields of economics, sociology, political science, biomedicine and epidemiology.
CHAPTER 4
RESEARCH FINDINGS

The preceding chapter presented the design, methods, and procedures. This chapter introduces the research findings for the study in four main sections. The first section presents variables used in the present study, their measures of central tendency and variability in the sample demographics particularly focusing on the difference between SI participants and non-participants. The next section presents a descriptive analysis of the effect of different factors on the course final grade. The overall purpose of the descriptive analysis is to provide the reader with a comprehensive portrayal of the data under study, specifically how groups of SI participants and non-participants vary before inferential statistics are considered. The final sections present the results of the regression analysis.

As mentioned before, the purpose of the present study is to address the following research questions:

1. What are the distributions of SI participants’ gender, ethnicity, ACT score, and high school percentile rank compared to those students who do not attend SI sessions?
2. What variables best predict the final grade in the course?
3. What is the effect of the number of SI sessions on course final grade?
4. Does the effect of SI vary by course?

Descriptive Analysis

In this section, descriptive statistics describe the characteristics of the sample and relationships among the variables under study. Frequencies, means, and standard deviations provide measures of central tendency and variability in the sample.
**Description of Variables.**

The choice of variables for this study is based on the literature review presented in Chapter 2 to understand how the participation in the SI program affects students’ success in entry-level science courses. Thus, the dependent variable for analyses is the course final grade. The independent variables include the number of SI sessions attended and other variables that can affect the course final grade such as demographic variables, academic achievement, and student involvement variables.

The sample of this study consists of 11,809 students who were enrolled in entry-level biology, chemistry, and mathematics courses during the academic years of 2006-2007, 2007-2008, 2008-2009, and 2009-2010. These courses are foundational science courses required for many STEM (science, technology, engineering, and math) majors and are foundational courses for the main body of students at the extensive doctorate university under study. At the same time, they are also high risk courses that have large classes and historically request Supplemental Instruction on a regular basis. All of the mentioned above classes had SI sessions offered throughout given semesters.

The number of the attended SI sessions is described by the variable signifying the number of sessions attended. The distribution of this variable is shown in Fig. 4.1 (the students who never attended SI sessions are excluded from the plot). Of all the students (11,809), those who went to at least one SI session comprise 31.1% (3,677), as opposed to 68.9% (8,132) to those who never went to a SI session. If the definition of SI participation as attending minimum five sessions holds, then, only 10.3% (1,261) of all the students were SI participants, leaving 89.3% (10,548) of students who did not participate in SI. The analysis of distributions of this variable for specific courses shows that the number of students
attending the SI programs decreases much faster in the case of Math than in the cases of Chemistry or Biology.

\[\text{Figure 4.1. The Distribution of the Number of SI Sessions Attended}\]
In terms of the academic major, 87.5% of the students in the sample are majoring in a STEM discipline. A little more than 7% of the students have an undecided or open major, and 5.1% are non-STEM majors. Table 4.1 shows SI attendance by student primary major. Among STEM majors 30.5% went to at least one SI session, and 69.5% never experienced SI. For the non-STEM majors, the percentage of students who went to SI at least once is higher; 31.9% while 68.1% never experienced SI. Among the rest of the students, those who have either an open or undecided major, 35.9% attended at least one SI session and 64.1% never went to SI sessions.

In case of defining SI participants as those who attended at least five sessions, the picture changes. Only 10.2% of STEM majors can be classified as SI participants, while 89.8% (9,277) would be non-participants. Among non-STEM majors, 15.0% are SI participants and 85.0% are non-participants. As for the open and undecided major students, 13.6% of students can be categorized as SI participants and 86.4% can be considered non-participants.
Table 4.1

*SI Attendance by Student Primary Major*

<table>
<thead>
<tr>
<th>Students’ Primary major</th>
<th>No SI sessions attended</th>
<th>One SI session attended</th>
<th>2-4 SI sessions attended</th>
<th>5 and more SI sessions attended</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>69.5%</td>
<td>8.2%</td>
<td>12.1%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Non-STEM</td>
<td>68.1%</td>
<td>6.8%</td>
<td>10.1%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Unknown</td>
<td>64.1%</td>
<td>8%</td>
<td>14.3%</td>
<td>13.6%</td>
</tr>
</tbody>
</table>

Table 4.2 shows the percentages of the number of SI sessions attended by course final grade. The analysis of these data shows that the largest percentages of the students who never attended the SI program are among the students receiving the grades of D and F. In the present study, the SI participants are defined as the students who attended more than four SI sessions. The analysis of the data presented in Table 4.2 shows that the percentage of SI participants dramatically drops with decrease of the course final grade. For instance, the number of SI participants who received the grade of “A” is more than 11 times larger than the number of SI participants who received the grade of “F”. Thus, the students who received higher grades displayed higher interest in SI sessions.
Table 4.2

*Number of SI Sessions Attended by Course Final Grade*

<table>
<thead>
<tr>
<th></th>
<th>No SI sessions attended</th>
<th>One SI session attended</th>
<th>2 SI sessions attended</th>
<th>3 SI sessions attended</th>
<th>4 SI sessions attended</th>
<th>More than 4 SI sessions attended</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A- to A</strong></td>
<td>67.72%</td>
<td>7.35%</td>
<td>6.32%</td>
<td>3.04%</td>
<td>2.41%</td>
<td>13.16%</td>
</tr>
<tr>
<td><strong>B- to B+</strong></td>
<td>64.34%</td>
<td>8.67%</td>
<td>6.69%</td>
<td>3.55%</td>
<td>2.97%</td>
<td>13.79%</td>
</tr>
<tr>
<td><strong>C- to C+</strong></td>
<td>65.94%</td>
<td>9.52%</td>
<td>7.03%</td>
<td>4.08%</td>
<td>3.25%</td>
<td>10.19%</td>
</tr>
<tr>
<td><strong>D- to D+</strong></td>
<td>75.76%</td>
<td>6.99%</td>
<td>5.55%</td>
<td>3.57%</td>
<td>1.52%</td>
<td>6.61%</td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>88.62%</td>
<td>4.83%</td>
<td>3.19%</td>
<td>1.00%</td>
<td>1.18%</td>
<td>1.18%</td>
</tr>
</tbody>
</table>

As the literature review in Chapter 2 indicates, the course final grade can depend on a number of factors, including attending SI sessions, students’ gender, and ethnicity, high school percentile rank, ACT score, and participation in a learning community. Therefore, I used the corresponding variables in this analysis. While the Gender variable simply takes one of the two possible values (female or male), the variable describing ethnicity is more complex. The Registrar’s Office at the university records the following ethnicity categories on student applications: American Indian or Alaskan Native, Black (not Hispanic), white (not Hispanic), Asian or Pacific Islander, Hispanic, Prefer not to indicate. The distribution of the Ethnicity variable is shown in Fig. 4.2. The white (not Hispanic) students constitute 89% of the sample, whereas other ethnicities constitute small fractions of the sample. Due to the small proportion of specific ethnic groups, it is not statistically viable to analyze the data for
each group separately. Therefore, a new variable was introduced. This variable had only two values: Not Minority and Ethnic Minority.

![Diagram showing the distribution of the Ethnicity Variable](chart.png)

**Figure 4.2. Distribution of the Ethnicity Variable**

High school percentile rank is a percentile ranking within the student’s high school graduating class; 99 is the highest rank and 1 is the lowest. Figure 4.3 shows the distribution of the high school percentile rank variable used in this analysis. The mean high school percentile rank of the students from the dataset under study is 77.1 with a standard deviation of 16.5.
The ACT composite score was calculated based on the 4-part college admission test: English, math, reading, and science. The scores range from 11 to 36. It seems reasonable to suggest that the effect of the SI program can be different for students with different ACT scores. For example, one can argue that the students with the highest ACT score may be less likely to benefit from the SI program. Therefore, the corresponding variable, ACT, was included in the present analysis. Figure 4.4 shows the distribution of ACT composite scores of the students from the dataset under study. The mean ACT composite score of the students in the sample is 25.5 with the standard deviation of 3.7.
Table 4.3 shows the mean ACT composite scores and high school percentile ranks for SI and Non-SI participants specifically for men and women. Among the Non-SI participants, the ACT score is higher for men than for women in spite of the fact that the high school percentile rank is higher for female students.
Table 4.3

*ACT Composite Scores and High School Percentile Ranks for SI and Non-SI Participants*

<table>
<thead>
<tr>
<th>Variable</th>
<th>SI Participant</th>
<th></th>
<th></th>
<th>Non-SI Participant</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>SD</td>
<td>Female</td>
<td>SD</td>
<td>Male</td>
<td>SD</td>
</tr>
<tr>
<td>ACT composite score</td>
<td>24.7</td>
<td>3.4</td>
<td>24.8</td>
<td>3.69</td>
<td>25.7</td>
<td>3.5</td>
</tr>
<tr>
<td>High school percentile rank</td>
<td>76.9</td>
<td>15.9</td>
<td>83.6</td>
<td>14.0</td>
<td>73.6</td>
<td>16.9</td>
</tr>
</tbody>
</table>
Most of the students (84.4%) from the dataset under study were participants of different learning communities. Due to the large number of learning communities, the cell-sizes of the individual communities tended to be low. Therefore, a new dichotomous variable, LCParticipant, was introduced; it defined if a student participates in at least one learning community.

**Descriptive Analysis of Effect of Different Factors on Course Final Grade.**

Table 4.4 presents the frequencies and percentage of the categorical variables used in the present study. Examination of this table demonstrates that the distributions of students by gender vary across different courses. For example, whereas two thirds of the students enrolled in Biology are women, the percentage of female students enrolled in Math is only 19%. The students who belong to different minority groups enroll in Biology, Chemistry, and Math in about the same percentages as other students. Regarding participation in learning communities, most of the students included in this study participated in at least one learning community; the difference between percentages for students enrolled in Biology, Chemistry, and Math is not large. At the same time, the participation in the SI program considerably varies from course to course, for instance, the percentage of SI participants among the students enrolled in Biology is 18% while the percentage of SI participants among the students enrolled in Math is only 4%.

Table 4.5 presents the frequencies and percentages divided by SI participation status. Analysis of these data reveals a considerable difference in the attendee of the SI program between the two genders: for example, only 7% of male students in the present dataset can be considered as SI participants whereas the corresponding percentage among female students is 16%. Among the three courses under study, the most pronounced difference
between the genders is in Chemistry: only 6% of male students in the present dataset can be considered SI participants while the corresponding percentage among female students is 14%.

The analysis of the data in Table 4.5 does not demonstrate any considerable difference in participation in the SI program between the students who belong to a minority group and the non-minority students. The data in Table 4.5 also do not show that percentage of the participants of learning communities who also participate in the SI program is larger than the same percentage for the students who do not participate in any learning community.
Table 4.4

*Frequencies and Percentage of the Categorical Variables Used in the Present Study*

<table>
<thead>
<tr>
<th>Course</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Learning Community Participant</th>
<th>Supplemental Instruction Participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>Female</td>
<td>Minority</td>
<td>2,480 (62%)</td>
<td>736 (18%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>450 (11%)</td>
<td>3,030 (82%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3,030 (82%)</td>
<td>736 (18%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2,480 (62%)</td>
<td>736 (18%)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>1,681 (49%)</td>
<td>358 (10%)</td>
<td>2,781 (86%)</td>
<td>351 (10%)</td>
</tr>
<tr>
<td></td>
<td>1,681 (49%)</td>
<td>358 (10%)</td>
<td>2,781 (86%)</td>
<td>351 (10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2,781 (86%)</td>
<td>351 (10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1,681 (49%)</td>
<td>351 (10%)</td>
</tr>
<tr>
<td>Math</td>
<td>811 (19%)</td>
<td>431 (10%)</td>
<td>3,379 (86%)</td>
<td>174 (4%)</td>
</tr>
<tr>
<td></td>
<td>811 (19%)</td>
<td>431 (10%)</td>
<td>3,379 (86%)</td>
<td>174 (4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3,379 (86%)</td>
<td>174 (4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>811 (19%)</td>
<td>174 (4%)</td>
</tr>
</tbody>
</table>
Table 4.5

*Frequencies and Percentages the Categorical Variables Used in the Present Study Divided by SI Participation Status*

<table>
<thead>
<tr>
<th>Course</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Learning Community Participant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Minority</td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>SI Participant (n=3292)</td>
<td>1,985 (80%)</td>
<td>378 (84%)</td>
</tr>
<tr>
<td></td>
<td>Non-SI Participant (n=536)</td>
<td>495 (20%)</td>
<td>72 (16%)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>SI Participant (n=3084)</td>
<td>1,443 (86%)</td>
<td>319 (89%)</td>
</tr>
<tr>
<td></td>
<td>Non-SI Participant (n=351)</td>
<td>238 (14%)</td>
<td>39 (11%)</td>
</tr>
<tr>
<td>Math</td>
<td>SI Participant (n=4101)</td>
<td>764 (94%)</td>
<td>415 (96%)</td>
</tr>
<tr>
<td></td>
<td>Non-SI Participant (n=174)</td>
<td>47 (6%)</td>
<td>16 (4%)</td>
</tr>
</tbody>
</table>
Table 4.6 presents means and standard deviations of high school percentile rank; ACT composite scores, and course final grades. The high school percentile rank is higher among the students who participated in the SI program whereas the ACT composite score is higher among non-SI participants. Both differences are statistically significant within the 95% confidence level. The mean course final grade is higher for all courses under study for the SI-participants than for the students who did not participate in the SI program. All differences are statistically significant within the 95% confidence level.

Table 4.6

Means and Standard Deviations of High School Percentile Rank; ACT Composite Scores, and Course Final Grades

<table>
<thead>
<tr>
<th>Variable</th>
<th>SI Participants</th>
<th>Non-SI Participants</th>
<th>diff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>High school percentile</td>
<td>1261</td>
<td>81.1</td>
<td>15.1</td>
</tr>
<tr>
<td>ACT composite score</td>
<td>1261</td>
<td>24.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Biology final grade</td>
<td>736</td>
<td>2.82</td>
<td>0.95</td>
</tr>
<tr>
<td>Chemistry final grade</td>
<td>351</td>
<td>2.90</td>
<td>0.79</td>
</tr>
<tr>
<td>Math final grade</td>
<td>174</td>
<td>2.69</td>
<td>0.92</td>
</tr>
</tbody>
</table>

* p< .05
Regression Analysis

Analysis of Research Question 2.

*What variables best predict the final grade in the course?*

A multivariate regression analysis was used to answer research Question 2 in the present study to find out what variables best predict the final grade in the course. First, all variables were divided into 3 blocks as summarized in Table 4.7. The first block included demographic variables such as gender and ethnicity; the second block included variables that showed academic achievement prior to enrolling at the university (high school percentile rank, and ACT composite score), and, finally, the third block consisted of variables that describe student engagement (the number of attended SI session, and participation in learning communities). The $R^2$ value was used to find out how well a particular block of variables explained the variance in the course final grade data. The obtained results are presented in Table 4.8. Examination of these data demonstrates that the course final grade is mostly determined by the academic achievement variables. However, for the present study, it is important to note that the effect of the student engagement variable, the number of the attended SI session, is statistically significant with 95% confidence.
Table 4.7

*Variable Blocks*

<table>
<thead>
<tr>
<th>Block</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>gender, ethnicity</td>
</tr>
<tr>
<td>2</td>
<td>ACT, high school percentile rank</td>
</tr>
<tr>
<td>3</td>
<td>number of SI sessions attended, learning community participant</td>
</tr>
</tbody>
</table>

Table 4.8

*Effect of the Used Variable Blocks on the Course Final Grade*

<table>
<thead>
<tr>
<th>Course</th>
<th>Blocks used</th>
<th>R²</th>
<th>R² change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>1</td>
<td>.0060*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-2</td>
<td>.3660*</td>
<td>.3600</td>
</tr>
<tr>
<td></td>
<td>1-3</td>
<td>.4068*</td>
<td>.0408</td>
</tr>
<tr>
<td>Chemistry</td>
<td>1</td>
<td>.0071*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-2</td>
<td>.3783*</td>
<td>.3712</td>
</tr>
<tr>
<td></td>
<td>1-3</td>
<td>.3853*</td>
<td>.0070</td>
</tr>
<tr>
<td>Math</td>
<td>1</td>
<td>.0134*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-2</td>
<td>.2164*</td>
<td>.2030</td>
</tr>
<tr>
<td></td>
<td>1-3</td>
<td>.2224*</td>
<td>.0060</td>
</tr>
</tbody>
</table>

* p < .05
Analysis of Research Questions 3-4.

What is the effect of the number of SI sessions on course final grade?

Does the effect of SI vary by course?

In order to address the aforementioned research questions 3 and 4, I used a multivariate regression model. Prior to running the analysis, I checked for multicollinearity. Whereas multicollinearity does not reduce the predictive power or reliability of the model as a whole, it can affect the regression coefficient associated with an individual predictor. A high degree of multicollinearity can also cause computer software packages to be unable to perform the matrix inversion that is required for computing the regression coefficients. One of the methods to detect multicollinearity is to construct a pair-wise correlation matrix that yields indications as to the likelihood that any given pair of independent variables is multicollinear. Table 4.9 presents pair-wise correlations for all the variables used in the regression analysis. The analysis of these data shows that there are no high correlations between any independent variables used in the present study. Regarding the number of SI sessions attended, Table 4.9 does show statistically significant correlations with gender, ACT score and high school percentile rank. Thus, the analysis of the data presented in Table 4.9 demonstrates that multicollinearity is not a problem in the present study.
Table 4.9

*Standardized Correlation Coefficients between Independent Variables.*

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>ACT</th>
<th>High school percentile rank</th>
<th>LC participant</th>
<th>The number of SI sessions attended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-0.040*</td>
<td>0.046*</td>
<td>-0.229*</td>
<td>-0.012</td>
<td>-0.153*</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td>-0.040*</td>
<td>-0.108*</td>
<td>-0.024*</td>
<td>0.003</td>
<td>-0.002</td>
<td></td>
</tr>
<tr>
<td>ACT</td>
<td>0.046*</td>
<td>-0.108*</td>
<td>0.372*</td>
<td>0.063*</td>
<td>-0.090*</td>
<td></td>
</tr>
<tr>
<td>High school percentile rank</td>
<td>-0.229*</td>
<td>-0.024*</td>
<td>0.372*</td>
<td>0.118*</td>
<td>0.088*</td>
<td></td>
</tr>
<tr>
<td>LC participant</td>
<td>-0.012</td>
<td>0.003</td>
<td>0.063*</td>
<td>0.118*</td>
<td>-0.006</td>
<td></td>
</tr>
<tr>
<td>The number of SI sessions attended</td>
<td>-0.153*</td>
<td>-0.002</td>
<td>-0.090*</td>
<td>0.088*</td>
<td>-0.006</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05.*
The results of the multivariate regression analysis for Biology are presented in Table 4.10. The examination of this table confirms that the strongest effect is from the academic achievement variables block but it also shows a significant effect of the number of SI sessions on the final grade. It should be emphasized that this effect is much larger than the effect of the participation in the Learning Communities which is not statistically significant.

Table 4.10

*Biology. Regression Analysis Results*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$ (standardized)</th>
<th>B (unstandardized)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.0704679</td>
<td>.1669712 $^*$</td>
<td>[.1058866, .2280558]</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>-.0345454</td>
<td>-.1282571 $^*$</td>
<td>[-.2208226, -.0356915]</td>
</tr>
<tr>
<td>ACT</td>
<td>.3206354</td>
<td>.0969543 $^*$</td>
<td>[.0883842, .1055245]</td>
</tr>
<tr>
<td>High school percentile rank</td>
<td>.3816076</td>
<td>.0259469 $^*$</td>
<td>[.0239649, .0279289]</td>
</tr>
<tr>
<td>SI sessions attended</td>
<td>.2043794</td>
<td>.0495575 $^*$</td>
<td>[.0434318, .0556833]</td>
</tr>
<tr>
<td>LC Participant</td>
<td>-.0239957</td>
<td>-.0716313</td>
<td>[-.1462974, .0030347]</td>
</tr>
</tbody>
</table>

* $p < .05$

The results of the multivariate regression analysis for Chemistry are presented in Table 4.11. The examination of this table confirms that the strongest effect is from the academic achievement variables block but it also shows a significant effect of the number of SI sessions on the final grade. It should be emphasized that this effect is much larger than
the effect of the participation in the learning communities or ethnicity category which are not statistically significant.

Table 4.11

*Chemistry: Regression Analysis Results*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$ (standardized)</th>
<th>$B$ (unstandardized)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.1349226</td>
<td>.2631649*</td>
<td>[.2080199, .3183099]</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>-.0147842</td>
<td>-.0474885</td>
<td>[-.1348452, .0398681]</td>
</tr>
<tr>
<td>ACT</td>
<td>.3269627</td>
<td>.0890443*</td>
<td>[.080857, .0972316]</td>
</tr>
<tr>
<td>High school percentile rank</td>
<td>.4116502</td>
<td>.0255162*</td>
<td>[.0236163, .0274162]</td>
</tr>
<tr>
<td>SI sessions attended</td>
<td>.084768</td>
<td>.0249152*</td>
<td>[.0167957, .0330347]</td>
</tr>
<tr>
<td>LC Participant</td>
<td>.0164554</td>
<td>.0457789</td>
<td>[-.0300678, .1216255]</td>
</tr>
</tbody>
</table>

* $p < .05.$

The results of the multivariate regression analysis for Math are presented in Table 4.12. The examination of this table again confirms that the strongest effect is from the high school percentile rank whereas the effect of the ACT composite score is much more moderate. There is a significant effect of the number of SI sessions on the final grade. The effect of the demographic block of variables and the participation in the learning communities are not statistically significant.
Table 4.12

*Math. Regression Analysis Results*

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>B</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(standardized)</td>
<td>(unstandardized)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>.0051542</td>
<td>.0171599</td>
<td>[-.0782762, .112596]</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>-.0166066</td>
<td>-.0730432</td>
<td>[-.1957562, .0496699]</td>
</tr>
<tr>
<td>ACT</td>
<td>.1485281</td>
<td>.0570644*</td>
<td>[.0458497, .0682791]</td>
</tr>
<tr>
<td>High school percentile rank</td>
<td>.3966209</td>
<td>.0314827*</td>
<td>[.0290949, .0338706]</td>
</tr>
<tr>
<td>SI sessions attended</td>
<td>.0769045</td>
<td>.0423545*</td>
<td>[.0270999, .057609]</td>
</tr>
<tr>
<td>LC Participant</td>
<td>.0118232</td>
<td>.0447312</td>
<td>[-.0609323, .1503948]</td>
</tr>
</tbody>
</table>

*p< .05

The comparison of the regression coefficients for the variable signifying the number of SI sessions attended between different courses is presented in Table 4.13. The analysis of this table indicates that the number of attended SI sessions affects the course final grade for Biology more than for Chemistry.
Table 4.13

*Regression Coefficients for the Number of SI Sessions Attended*

<table>
<thead>
<tr>
<th>Course</th>
<th>( \beta ) (standardized)</th>
<th>( B ) (unstandardized)</th>
<th>95% CI for ( B )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>.2043794</td>
<td>.0495575 *</td>
<td>[.0434318, .0556833]</td>
</tr>
<tr>
<td>Chemistry</td>
<td>.084768</td>
<td>.0249152 *</td>
<td>[.0167957, .0330347]</td>
</tr>
<tr>
<td>Math</td>
<td>.0769045</td>
<td>.0423545 *</td>
<td>[.0270999, .057609]</td>
</tr>
</tbody>
</table>
CHAPTER 5
DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

In this chapter, first, I discuss the main findings described in Chapter 4 in respect to research questions and hypotheses. Next, I summarize the conclusions and, then, I provide some recommendations for further action as well as recommendations for future research.

Discussion

The present study was focused on the following research questions:

1. What are the distributions of SI participants’ gender, ethnicity, ACT score, and high school percentile rank compared to those students who do not attend SI sessions?

2. What variables best predict the final grade in the course?

3. What is the effect of the number of SI sessions on course final grade?

4. Does the effect of SI vary by course?

To address these questions, several hypotheses were proposed. Below, I summarize the findings described in Chapter 4 to accept or reject the proposed hypotheses.

1.1. There is no difference in gender composition between participants and non-participants of the SI program.

I failed to accept the null hypothesis. Analysis of the data revealed a considerable difference in the attendee of the SI program between the genders: for example, only 7% of male students in the present dataset can be considered as SI participants (that is they attended more than 4 sessions) whereas the corresponding percentage among female students is 16%. This finding agrees with the theoretical background and findings of a qualitative study of a SI program at the University of Wisconsin (River Falls) conducted by Lundeberg and Moch (1995). They noted that many women prefer the connected knowing learning style which is a
personal, cooperative approach to learning, where values tie theory to experiences and which stresses belief rather than doubt. This style can be more naturally realized in SI sessions rather than the traditional pedagogical style used by most classroom professors. The fact that only 7% of men attend more than four SI sessions per semester also signifies a problem of attracting and retaining male students at SI sessions.

Among the three courses under study, the most pronounced difference between the genders is in Chemistry: only 6% of male students in the present dataset can be considered SI participants while the corresponding percentage among female students is 14%. This finding calls for a qualitative case study of a Chemistry SI program investigating possible causes of this situation because in both Biology and Math SI programs the difference in participation between the genders is only 4% and 2% respectively.

1.2. There is no difference in ethnic composition between participants and non-participants of the SI program.

This hypothesis was accepted. The analysis of the data did not show any significant difference in participation in the SI program between the students who belong to a minority group and the non-minority students. Thus, both minority and non-minority students equally participate in SI and should be encouraged more to utilize this option.

1.3. There is no difference in average ACT score between SI participants and non-participants.

I failed to accept this hypothesis. The analysis of the data shows that SI participants on average have lower ACT score than non-participants which probably indicates the lack of certain academic knowledge and skills that contribute to better success on standardized tests. This could mean that the SI program may get a reputation of a program mostly designed for
lower-achieving students. Such a reputation does not correspond to the original goals of the program. In this light, the students with higher ACT scores may ignore the SI option because they may not be aware of the goals of this program. As a result, such students miss the benefits of the SI program.

1.4. *There is no difference in average high school rank between participants and non-participants of the SI program.*

I failed to reject this hypothesis. The average high school percentile rank of SI participants is higher than the average high school percentile rank of non-participants. Considering this and the previous hypothesis (the ACT score), SI participants possibly possess certain characteristics associated with a high school percentile rank that contribute to higher engagement and persistence in acquiring knowledge and skills needed for academic success. Thus, the academic advisers of students with low high school percentile rank should especially encourage their advisees to participate in the SI program. Perhaps, the Academic Success Center should inform academic advisers about the fact that the lower high school percentile rank students frequently choose to ignore the SI program from which they could really benefit. It should be noted that at this point most of the advertising of the SI program is focused simply on the fact that the SI participation leads to higher course final grades rather than targeting specific student groups.

2. *The ACT score, high school rank, and demographics are not the best predictors of the course final grade.*

I failed to accept the hypotheses regarding the ACT score and high school rank but we accepted the hypothesis regarding the demographic variables. The block entry multivariate regression analysis showed that the demographic block of variables (gender and
ethnicity) explain only 6-13 % of the data on the final course grade. The academic achievement block of variables (ACT score and high school rank) explains 20-36 % of the data on the final course grade. Finally, the student engagement block of variables (participation in the SI program and learning communities) explains only 0.6-4 % of the data on the final course grade.

It should be noted that the ACT score measures high school students' general educational development and their capability to complete college-level work with the multiple choice tests covering four skill areas: English, mathematics, reading, and science. It is possible that the analysis in the present study would give a better guidance if more specific scores were used. For example, to evaluate the effect of the SI program on the final course grade in Math only the corresponding part of the ACT examination should be used. Unfortunately, such data were not available within the used dataset but they can be collected in the future.

3. The course final grade is not correlated with the number of the SI sessions attended.

The null hypothesis was rejected. The multivariate regression analysis of the data for all courses showed positive correlations between the final course grade and the number of SI sessions attended. This clearly demonstrates the effectiveness of the SI program.

Considering this result, it seems unfortunate that only 11 % of students choose to participate in the SI program. Moreover, 68.9% students never went to a SI session. A special study should be conducted to explore why so many students ignore this option. Another important observation is that after the first four SI sessions the number of participants decreases in almost 5 times. Taking into account that the effectiveness of the SI program for students who decided to continue participating was proven in the present study,
the important open question is why majority of the students who attended the first four sessions decided to quit the SI program. There may be several possible answers to this question. For instance, the students who stopped attending the SI program may not have been satisfied with the level of difficulty at which questions were discussed during SI sessions. Another reason may be that they did not quit the SI program but just started to attend SI sessions at the end of the semester. Unfortunately, the data set used in the present study does not contain any information about when students started to attend the SI sessions. Such data can be included in the future data collection. It would be also useful to conduct a survey to investigate why students missed SI sessions.

4. There is no difference in the effect of the SI program for different courses.

This hypothesis was rejected. The final course grade correlates with the number of SI sessions attended significantly stronger for students who took Biology than for students who took Chemistry. In the case of Math, the confidence interval for the correlation coefficient is so wide that no statistically meaningful conclusion can be derived. It will be useful to research in detail the causes of differences in the effectiveness of the SI program for different courses.

Conclusions

The analysis of the data demonstrated that the final course grade for all three courses considered in the present study is higher for SI-participants than for non-participants. This finding is even more impressive taking into account that the analysis of the same data shows that the SI participants on average have lower ACT score than the non-participants. Moreover, the final course grade positively correlates with the number of SI sessions
attended meaning that the more SI sessions the students attend the higher grade they receive for the course.
Recommendations

College services and the Academic Success Center may consider how to encourage participation of more students overall and men in particular, how to keep the students interested in SI sessions in order to give them an opportunity to maximally benefit from SI, and how to stimulate the interest of the faculty whose support can influence successful resolution of SI participation and retention problems. A special attention of students and the faculty should be drawn to explanation of the actual goals of the SI program. A qualitative study could be performed to find out if there are any stereotypes about the SI program which prevent some particular groups of students from participation in this program.

The Academic Success Center should probably include in the collection of data the information about when students started to attend the SI sessions. It will be also very useful to conduct a survey among the students who attended only 1 SI sessions to find out what was the reason not to use this option further.

Due to the small proportion of specific ethnic groups, it was not possible to draw any conclusion for particular minority groups. Therefore, in order to better understand how to better attract the minorities to participating in the SI program and how to evaluate the effect of this program on their course final grade, a qualitative analysis should be conducted.

In regard to other further research, qualitative case studies of SI programs for specific disciplines can benefit effective teaching and, consequently, student success in respective subject areas. Quantitative studies with more specific academic background and possibly motivational characteristics variables will be useful for improving effectiveness of the SI model overall.
REFERENCES


## APPENDIX

### Description of variables

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
<th>Scale</th>
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<tbody>
<tr>
<td>Course grade (Grade1)</td>
<td>The grade the student received for a particular course</td>
<td>1 = F&lt;br&gt;2 = D-&lt;br&gt;3 = D&lt;br&gt;4 = D+&lt;br&gt;5 = C-&lt;br&gt;6 = C&lt;br&gt;7 = C+&lt;br&gt;8 = B-&lt;br&gt;9 = B&lt;br&gt;10 = B +&lt;br&gt;11 = A-&lt;br&gt;12 = A</td>
</tr>
<tr>
<td>Course grade (Grade2)</td>
<td>The normalized grade obtained from Grade1.</td>
<td>0.000 = F&lt;br&gt;0.667 = D-&lt;br&gt;1.000 = D&lt;br&gt;1.333 = D+&lt;br&gt;1.667 = C-&lt;br&gt;2.000 = C&lt;br&gt;2.333 = C+&lt;br&gt;2.667 = B-&lt;br&gt;3.000 = B&lt;br&gt;3.333 = B+&lt;br&gt;3.667 = A-&lt;br&gt;4.000 = A</td>
</tr>
<tr>
<td>ACT Composite score (act)</td>
<td>The ACT score is the average of four test scores rounded to the nearest tenth number. The four parts of the assessment are English, mathematics, reading, and science. The scores range from 1 to 36.</td>
<td>Continuous</td>
</tr>
<tr>
<td>tat</td>
<td>Total # SI sessions attended</td>
<td>Continuous</td>
</tr>
<tr>
<td>HS_Rank</td>
<td>High school percentile rank is a percentile ranking within the student’s high school graduating class, with 99 highest and 1 lowest.</td>
<td>Continuous</td>
</tr>
<tr>
<td>Gender</td>
<td>Student gender based on institutional information.</td>
<td>0 = Female&lt;br&gt;1 = Male</td>
</tr>
<tr>
<td>EthnicityCat</td>
<td>Ethnicity Categories</td>
<td>0 = Not minority&lt;br&gt;1 = Ethnic minority</td>
</tr>
<tr>
<td>LCPParticipant</td>
<td>Learning Community Participant</td>
<td>0 = No&lt;br&gt;1 = Member</td>
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