THE EFFICACY OF
THE SUPPLEMENTAL INSTRUCTION PROGRAM AS IMPLEMENTED
IN MATH 152 CALCULUS FOR NON-MAJORS AT UNBC

A Technical Report Delivered to

the University of Northern British Columbia's

Mathematics Program and Learning Skills Centre

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JANUARY 2006

The Supplemental Instruction Program at UNBC

Executive Summary

Supplemental Instruction (SI) has been available in select courses for several years at UNBC. In particular it has been offered with MATH 152, Calculus for Non-Majors, since the winter semester, 2002. The decision to implement SI was made in response to an overwhelming demand on mathematics support services at the Learning Skills Centre (LSC). MATH 152 was selected for the SI pilot because the students in this course drew heavily on LSC services. There was high enrollment in the course (100-150 students per section), and there were poor success rates. The SI program in MATH 152 forms the basis of a three year study which culminated with the development of this report. This report answers two related questions. First, does participation in SI improve student achievement, as measured by course letter grade? Second, does participation in SI improve the pass/fail rate in the course?

SI is a voluntary program that incorporates cooperative / collaborative learning in small, peer-led, group settings in order to integrate instruction in learning and reasoning skills with content of the course with which the SI is paired. Furthermore, SI provides students with the experiential, collaborative, and active learning opportunities envisioned by UNBC as it moves forward in the academic visioning process (Pedagogical Academic Themes in the Penultimate Report: Phase 1 of the Academic Visioning Initiative, 2006) .

For the analyses, students were initially placed in one of three categories: no opportunity to obtain SI – 390 students, opted not to participate in SI – 600, and participated in SI – 269. Prior student success, a combination of ability and motivation, was statistically controlled for in the analyses through the use of incoming grade point

average. The no-opportunity and the opted-not-to groups were found to be equivalent groups and so were amalgamated to form the non-participant group. A 2 x 2 x 1 ANCOVA (SI by gender with prior GPA) indicated that prior GPA was a useful covariate. The effect of SI participation after prior GPA and gender were controlled for was statistically significant ($p < .0005$) and practically significant ($d=.48$; or a 2-letter grade improvement). The adjusted mean letter grade for the SI participants was a “B-” compared to a “C” for non-participants. A sequential binary logistic regression was used for the pass/fail analysis. There was a statistically significant difference between the first model containing both prior GPA and gender and the second (full) model which also contained SI (chi-square = 41.19, $p < 1.4E-10$). In the full model gender did not contribute significantly ($p = .24$). The odds of succeeding in the course were 2.7 times greater for SI participants than for non-participants. The proportion of SI participants that earned a D, F, or W grade in the mathematics course was 28%, while the non-participant group D, F, W rate remained at 53%. These finding are consistent across genders. These results are consistent with the SI research literature.

Supplemental Instruction is an effective method for boosting success rates in difficult undergraduate courses with concentrated mathematical content. Based on the greatly increased grade point average and the substantially decreased failure rates, the authors strongly suggest that the Supplemental Instruction program at UNBC not only be continued but also that funding be made available for the necessary expansion into other courses and subject areas warranting this attention.

Introduction

Decision to Implement Supplemental Instruction at UNBC

Supplemental Instruction (SI) was initiated at UNBC in response to a growing demand for mathematics assistance. In 2001, the requests for mathematics help through the one-to-one tutoring program offered at the Learning Skills Centre (LSC) began to exceed the capabilities of the Centre. Students were unable to schedule appointments with mathematics tutors in a timely manner. The LSC lacked space to accommodate hiring additional tutors. Furthermore, hiring additional tutors posed considerable difficulty as there were few highly competent third and fourth year mathematics students available for tutoring. As a result of these issues, the LSC staff looked to other options for providing mathematics assistance.

After careful collaboration with the Mathematics Program, a decision was made to pilot SI in the course, MATH 152 Calculus for Non-Majors, as a large number of students from this course drew heavily on LSC services. By attempting small group, peer facilitated review sessions for this Calculus class, it was hoped that more students could be served with less expenditure in terms of cost and human resources. In addition there was a need for a new approach in providing mathematics support. Traditional tutorials had always been available for this course but were poorly attended by students except on occasion just prior to an exam. Providing additional tutorials would not address the problems associated with this course. Mathematics tutorials at UNBC, and many other post-secondary institutions, often have the following structure. Students come to the tutorial and pose questions related to the course. Generally, the tutorial assistant solves the question posed by the student on the board. Most tutorial assistants, although knowledgeable with the content, receive little or no training in learning strategies. Frequently, the student at a tutorial session is merely a passive observer. Conversely, the SI program has been developed on sound pedagogical theories for learning. Students are active participants in the learning, they work collaboratively to solve problems, and the SI leader serves as the near-peer facilitator, guiding the students to a higher level of understanding.

Once the decision was made to pilot SI, the next step was to establish the program in the course. This process began by finding model students who had previously earned an A or A+ in the course. These students went through a rigorous interview process. Those who were finally selected were provided 10 – 15 hours of training over the course of the semester. The training was carefully designed to ensure that the leaders had the essential tools to facilitate SI sessions in the manner prescribed by SI philosophy and program guidelines.

Supplemental Instruction was introduced in the first two weeks of classes to provide proactive support. The LSC Supervisor and the SI Leaders worked together to determine a schedule to provide three 50-minute sessions per week per leader in efforts to provide accessibility for all students enrolled. Scheduling difficulties did occur as it is difficult to accommodate all student schedules. All reasonable attempts to schedule SI sessions so that all students were able to attend at least one session per week, have been made throughout the duration of SI at this institution.

Instructor support, an integral component of successful SI, was obtained for all Calculus for Non-Major classes prior to implementation of the program. All students were informed of the support available through the SI program and of other mathematics assistance available to them at the university. Other assistance included one-to-one tutoring services offered through the LSC, instructor office hours, and the traditional tutorials offered for this course. All services were, and continue to be, free. Tutorials were still available for the course initially. However, after three semesters, it became apparent that students were not attending the traditional tutorials even though excellent mathematical students were placed as tutorial assistants for Mathematics 152, the course for which SI was introduced. They were attending SI. Tutorials were not offered in subsequent semesters for this course.

As a result of practical experience at this institution and using SI guidelines, it was determined that scheduling one SI Leader for every 50 students enrolled in the Calculus course provided optimal coverage, while minimizing costs associated with having too many SI Leaders offering poorly attended sessions. Student attendance was monitored by the SI leaders. Students record their name on a new attendance sheet at the start of each month and tick a box for the current date.

Supervision is also an essential component of this program. Even with an initial eight-hour training session in group facilitation methods and instruction in SI philosophy and guidelines, leaders can slip back into the familiar tutorial structure where they answer student questions at the board. Ongoing training and monitoring for approved SI practices was essential. The UNBC Math/Stats Advisor (the first author) underwent a prescribed three-day training program at University of Missouri – Kansas City (UMKC) to ensure that correct practices were undertaken when establishing, supervising, and monitoring the SI program at UNBC.

The Nature of Supplemental Instruction

Many academic support programs have been developed to assist low achieving students in first-year courses at the post-secondary level. In contrast, Supplemental Instruction was developed to improve the learning of students in historically difficult courses. The SI program evolved in response to the academic needs of students enrolled in problematic courses in professional programs such as the School of Medicine, Dentistry, and Pharmacy at the UMKC (Martin, 1973). It has since been used extensively in a wide range of graduate, undergraduate, and professional school courses, and in a wide range of disciplines (Center for Supplemental Instruction, 2000; Martin & Arendale, 1992).

The guiding principles of the SI program evolved as a result of collaborative learning theory and a need for improved practices that extended beyond generic study skills. Martin (1973) petitioned for a program that integrated reasoning and study skills with course content; not isolated from it. Consequently, the SI program developed with the following principles.

Service is attached directly to a specific course. Reading, studying, and problem-solving skills are offered in the context of the targeted, traditionally difficult course. Instruction in these skills is developed out of student questions and concerns as they occur within the course.

Service is proactive rather than reactive. The SI program is implemented in the first two weeks of class to provide assistance before students earn a critical D or F grade on an assignment or examination.

Supplemental Instruction 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 on what occurred in lecture. The SI Leader, a student who has demonstrated superior academic achievement in the course, is provided with a timely review and often gains deeper insight into the course content upon hearing the concepts explained for a second time. The leader is also able to draw on his/her knowledge of the objectives of the course, thus creating an ideal learning environment for students attending the SI sessions as they strive for success in the course.

Supplemental Instruction is not a remedial program. The program evolved as a means to improve student achievement in historically difficult courses. Many of the students attending the sessions are not underachievers or under-prepared. In fact, studies on affect and SI have pointed to the exact opposite. Internal motivation is an integral component of students who participate in the SI program (Visor, Johnson, & Cole, 1992).

Supplemental Instruction programs are designed to provide a high-degree of student interaction and mutual support. Supplemental Instruction has relied upon the power of group study for over 30 years and is built on the practice of collaborative learning and interaction through peer study groups facilitated by a near-peer (Center for Supplemental Instruction, 2000). Near-peers are students who have previously taken the course but may only be a year or two ahead of the students in the course.

Supplemental Instruction leaders are trained. One of the key elements of SI is extensive SI Leader training in group facilitation practices. For example, the SI Leaders are trained to use proactive and participative activities in the sessions such as ‘think, pair, share’ where students are encouraged to brainstorm ideas, pair up with another student, and discuss their views or approaches to problem solving. The leaders are trained in questioning techniques based on Bloom’s taxonomy (Bloom, 1956, in Le Francois, 1997). Bloom’s taxonomy is comprised of six levels: knowledge (primarily recall of information such as formulas), comprehension (articulates and understands the meaning), application (primarily performing operations in mathematics), analysis (problem solving), synthesis (combining concepts for a deeper understanding), and evaluation (taking judgments on the basis of the given data). Supplemental Instruction Leaders assess skills not only through questioning, but also through the development of quizzes that incorporate applications of Bloom’s taxonomy. These quizzes are not for marks, are often open book, and are generally completed in collaboration with other students. Quizzes provide students an opportunity to practice for tests, thus reducing the test anxiety that often accompanies mathematics tests and helps build confidence. The SI Leader draws on his/her previous knowledge of course goals and what is currently being discussed in lecture to prepare practice questions and tests. SI Leaders implement strategies in sessions such as generating a table of contents, built on student input. These tables assist students in summarizing the key concepts taught over a certain time period, perhaps to be tested in an upcoming exam. Another strategy is to have students generate potential test questions; compile a quiz based on these questions; administer the quiz; and then discuss solutions.

It is these practices that are currently forefront on theories of learning and reflect theory by creating opportunity for discourse in the language of the discipline (Chapman, 1995; Gee, 1996; Kenney & Kallsion, 1994; Linn & Kessel, 1996; Steele, 2001; Wells, 2001b). Many of the guiding principles of SI, although arising out of practice, have a solid theoretical underpinning. The SI program at UNBC has been patterned on this model. Sessions are small-group, peer-led, and interactive. They are aimed at improving student confidence and competence in the targeted course. Participation in SI is voluntary, free-of-charge, and is open to all students in the course. Students at all levels of ability are encouraged to attend SI sessions.

Studies have shown that SI has improved student achievement, most notably in the decrease of D and F letter grades and increased GPA among students who attend SI (Blanc, DeBuhr, & Martin, 1983; Burmeister, Kenney, & Nice, 1996; Center for Supplemental Instruction, 2000; Congos & Schoeps, 1998; Kenney, 1989; Kenney & Kallison, 1994). In 1981, and again in 1992, the U.S. Department of Education validated the Supplemental Instruction Program as an *Exemplary Educational Program* (Martin & Arendale, 1992). The SI Program is one of only two programs that are officially recognized by the U.S. Department of Education as contributing to increasing student graduation rates (Martin & Arendale, 1992). See Appendix A for a more complete review of the research on SI including a discussion on the underpinning philosophy that supports learning of Mathematics in the SI structured environment.

Data Analysis

Summary statistics were compiled for all sections of Mathematics 152 with SI support. An example from one semester of classes is provided in Tables 1 and 2. A student was considered an SI participant if 25% or more of the sessions (7 sessions in this example) were attended. Data from other years were placed in Appendix B. During 2003 23% of the students participated in the SI program (SI) while the remainder (NON-SI) did not. The letter grade distributions for both these groups appear slightly bimodal with larger proportions of students with the A's and D/F categories.

Table 1

WINTER 2003- Mathematics 152 (Calculus for Non-Majors)

Grade Point	SI	(%) of class	NON SI	(%) of class
A+ (4.33)	7	20.6	11	9.8
A (4.00)	3	8.8	9	8.0
A- (3.67)	2	5.9	8	7.1
B+ (3.33)	2	5.9	4	3.6
B (3.00)	2	5.9	6	5.4
B- (2.67)	3	8.8	7	6.2
C+ (2.33)	3	8.8	5	4.5
C (2.00)	3	8.8	6	5.4
C- (1.67)	3	8.8	7	6.3
D (1.00)	1	3.0	22	19.6
F (0.00)	5	14.7	27	24.1
Total	34	100.0	112	100.0

Comparison of the proportions of students in the D/F categories indicate lower failure rates for SI students. Examination of Table 2 reveals that the SI participants completed the course with a mean letter grade of 2.63, that is, a B- while the non-SI participants had a mean of 1.97, a C. These results are merely suggestive of the efficacy of SI as the issue of bias due to self selection has not been accounted for in these data; recall the comments of Vison, Johnson, & Coles, 1992. Note that SI students were asked to rate their satisfaction with SI on a scale of 1 to 6; their reported mean was 5.8. Again self selection must be considered as those who were dissatisfied with SI likely left the program.

Table 2

Summary Chart (Winter 2003)

Total student enrollment for two sections of Mathematics 152	147
Number of SI sessions offered in term	126
Total number and percentage of students who attended at least one SI	(37%) 54
Total contact hours of SI participating students	676
Mean number of sessions attended by SI participants	12.5
Mean size of SI sessions	5.4
Mean SI Participant Evaluation Rating of Helpfulness of SI	5.4
Mean Final Course Grade of SI Participants	2.63
Mean Final Course Grade of Non-SI Participants	1.97
Percentage of SI students receiving a D or F grade	17.7
Percentage of Non-SI students receiving a D or F grade	43.7

The summary evaluations did not address factors such as each student’s natural academic ability, a common flaw in the SI research. This study addresses the contributing factors that impact final course grade, aspects such as ability and motivation, and also gender, to answer the question, “Does Supplemental Instruction improve the final course grades of students and success rates of students enrolled in Calculus for Non-Majors?”

Final grades and SI attendance were collected from winter 2002 to fall 2004 resulting in data for approximately 870 students enrolled in 9 sections of the course. Of these, 269 students were classified as SI participants (attended 5 or more SI sessions) forming the first group, the remaining 600 non-participants formed a second group. Data was obtained for a further 390 students enrolled in MATH 152 from the year prior to SI implementation, forming a third pre-treatment group. For the purposes of analysis, the final grades (the dependent variable) were converted to numerical values and used to compile the statistics that follow. Note that this scale is in a different metric than the UNBC letter grade scale. One is merely a mathematical (linear) transformation of the other. The whole number values were needed for the statistical analysis that was ultimately carried out. Also note that the authors decided to give a Withdraw (W) a lower score than a Fail (F) as they believe that the common case of a student withdrawing from a course was an assessment by the student as to the probable lack of positive outcome in the course.

Table 3

Final MATH 152 Grades Numerical Conversion

A+	12	C+	6
A	11	C	5
A-	10	C-	4
B+	.9	D	3
B	.8	F	2
B-	.7	W	1

In the case of an F, the student had at least remained in the course long enough to be given an F. S/he may have written the final examination in the course with the expectation of passing the course. Summary statistics were calculated for each of the three groups, Pre-SI, SI, and Non-SI. These are presented in Table 4.

Table 4

Summary Statistics for the SI Groups

Treatment	N	Mean final grade	Letter Grade	SD
Pre-SI (no opportunity to attend)	390	4.9	(C-/C)	3.4
Non-SI (attended < 5 times)	600	5.4	(C)	3.7
SI (participant)	269	6.9	(C+/B-)	3.5

The lower mean, 4.9, of the Pre-SI group, a mixture of Non-SI and SI individuals had there been the opportunity to participate, suggested either random variation in achievement, or possibly changing standards or even grade inflation. However, when a one factor ANOVA test was applied, and evidence of statistically different means were found ($F_{.05,2} = 26.779$, $p < .0005$), post hoc testing revealed that the only differences were between the SI group and the other two groups. The non-participants did not differ from the Pre-SI group. This is suggestive of a lack of ability / motivation difference between the pre-SI and non-SI groups.

Success in MATH 152

While an increase in letter grade is a desirable result, pass or failure in the course may be the more crucial issue for some students. Success is important for retention as students who succeed usually persist in their studies.

A two-way contingency table was used to evaluate relationship between final grades and the three groups: Pre-SI, SI participant, and non-participant. Categories used were success/failure with DFW grades in failure group, the rest in success. D grades were included in the failure category since a D grade often prohibits students taking post-requisite courses. In this instance, a Pearson chi-square test was judged appropriate. The raw data are presented in Table 5.

The Pearson Chi-square test result was statistically significant ($\chi^2_{.05,2} = 43.4$, $p < .0005$). The success rate of the SI group, 72.5%, is a stark contrast to the success rate of approximately 50% for either of the Non-SI or Pre-SI groups. Preliminary results **would appear to** indicate that

- SI participants earn statistically improved final grades.

- SI participants earn practically improved final grades (Cohen's d = 0.58 or about 1.75 letter grades higher).
- SI participants succeed at higher rates (72.5 vs. 50 %).
- No evidence to support differentiation between pre-treatment and non-participant groups – combined for following analyses.

Table 5

Proportions of Success or Failure by Treatment Group

Treatment	Count	Failure	Success
Pre-treat	OBS	205	185
	EXP	174	216
	% of group	52.6 %	47.4 %
Non-part	OBS	283	317
	EXP	268	332
	% of group	47.2 %	52.8 %
SI part	OBS	74	195
	EXP	120	150
	% of group	27.5 %	72.5 %

However, the effect of self-selection into SI based on achievement cannot yet be ruled out, that is, students that have displayed more motivation to do well or demonstrated more ability to achieve may have opted to take SI sessions in greater proportions than their lower achieving counterparts.

SI Effects Corrected for Prior Academic Achievement

The next two analyses, an analysis of covariance (ANCOVA) and a binary logistic regression, were performed to correct for the differing prior achievement between groups that might have resulted due to student self-selection into groups. A variable based on Incoming Grade Point Average was established based on prior transcript information. In addition, gender is considered. There are several reasons for including gender in the analysis. One, gender differences in mathematics performances have been of interest for decades. Current research suggests little or no difference in performance. Two, the inclusion of gender allowed the researchers to determine whether SI has differing degrees of efficacy for male or female students. Three, the inclusion of gender as a variable makes the statistical analysis more sensitive, that is, effects have less chance of being overlooked in the analyses. The first analysis, ANCOVA, is appropriate for the investigation of change in final letter grade due to the implementation of SI. The second analysis, binary logistic regression is appropriate for the success / failure analysis. For these two analyses, the Pre-SI and the Non-SI student groups were amalgamated under the name non-participants.

Analysis of Covariance (ANCOVA)

ANCOVA was performed to assess the difference in final grades between SI participants and non-participants after adjusting for ability through use of incoming GPA as a covariate. Descriptive statistics by SI treatment group and gender are presented in Table 6 while the summary ANCOVA results are presented in Table 7.

Table 6

Mean Final Grades (By Gender and SI treatment)

SI 2 category	Gender	Number	Mean grade	SD
Non-SI Participants	M F Overall	509 481 990	4.8 (C-) 5.6 (C) 5.2 (C)	3.4 3.7 3.6
SI Participants	M F Overall	135 134 269	6.6 (C+) 7.2 (B-) 6.9 (C+/B-)	3.5 3.6 3.6

The ANCOVA results are interpreted as follows. The incoming GPA is a statistically significant predictor of success in MATH 152 ($p < .0005$). This was expected; it would not have been included in the analysis had it not been true. The SI/gender interaction is non-significant ($p > .05$), that is, there is no differing effect of the treatment for males and females. This result is desirable; one would not want a program that was effective for one gender and not for the other. There are differences in performance between males and females, even after correcting for Incoming GPA! Participation in SI improves grades even after incoming GPA, and gender are accounted for.

Table 7

Summary of ANCOVA Results

Source	df	F	p
Incoming GPA	1	316.9	.000
SI treatment	1	51.7	.000
Gender	1	7.5	.006
SI/Gender interaction	1	1.0	.316

Further analysis indicates that the SI treatment is of practical significance as well, Cohen's d = 0.5, that is 0.5 standard deviation, about 1.8 letter grades higher. This is considered a medium size treatment effect. In contrast gender was statistically significant but a Cohen's d value of 0.2 represents a small effect size, or less than one letter grade difference between males and females.

Sequential Binary Logistic Regression

This test was performed to determine if SI participation contributes significantly to prediction of success or failure after the effects of incoming GPA and gender are accounted for. The results are displayed in Table 8. The first mathematical model tests whether Incoming GPA and gender statistically predict outcomes of success or failure better than no model at all. The chance of getting this value or larger ($\chi^{2}_{.05,2} = 182.931$) are less than 5 times in 10 000 ($p < .0005$). Therefore we accept the idea that Incoming GPA and gender are predictors of success/failure in MATH 152 for the population of students who take this course. The SI treatment was then added to the model and as we might expect these three predictors as a group are successful at predicting success. Note that the chi-square value increases with the added predictor.

Table 8

Sequential Logistic Regression Results

Model	Chi-Square	df	p	-2 log likelihood
Model 1 GPA, gender	182.931	2	.000	1547.910
Model 2 GPA, gender, SI	224.120	3	.000	1506.721

The difference in chi-square values between the two models ($\chi^{2}_{.05,1} = 41.189$, $p < .0005$) confirms that SI participation is a significant contributor to prediction of success in the course, MATH 152, Calculus for Non-Majors, after both gender differences and incoming GPA were accounted for. The effects of each the three predictors were examined in more detail. These results are presented in Table 9. In this analysis gender and Incoming GPA are evaluated separately.

Table 9

Variables in the Prediction Model

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
SI	.992	.160	38.333	1	.000	2.696
GPA	1.103	.092	144.089	1	.000	3.014
Gender	.146	.125	1.365	1	.243	1.157
Constant	-4.157	.364	130.205	1	.000	.016

The Wald test results are used to examine the statistical significance of each of the predictors, SI participation, Incoming GPA, and gender, in this model. As was already described, SI treatment was a significant predictor of success ($p < .0005$) as was Incoming GPA ($p < .0005$). However gender was not significant ($p = .243$) when the effects of incoming GPA were taken into account. This sequential model demonstrated that SI participation had an effect on success in MATH 152, Calculus for Non-majors, after the issues of possible selection bias were accounted for. Prior GPA, an achievement measure, is not only a measure of ability but is very likely to be influenced by motivation as well. As with the ANCOVA, there is a measure of the importance or practicality of these predictors. The quantity e^B, EXP(B) in Table 9, represents the ratio change in the odds of success for a one-unit change in predictor. For example: the odds of a person succeeding are 2.696 times greater as a result of SI participation while one unit of Incoming GPA (Note on UNBC's scale, approximately 3 letter grades) had only a slightly greater effect. Gender, if it were statistically significant was seen to be of no predictive value as the odds ratio is approximately 1. This mathematical model accurately predicts a student outcome 68% of the time.

Conclusions

The evaluation of the SI program for MATH 152, Calculus for Non-majors, involved two highly related questions. One: does SI participation result in increased achievement in the course? The program of Supplemental Instruction as delivered at UNBC can be credited with a two letter grade increase for students participating in the program. Neither the incoming GPA, nor the gender of the student can be used to explain the increase. The advantage of SI participation is roughly equal to that of 2 UNBC letter grades of incoming GPA. Male and female students benefit equally from SI participation. When we focus our concern on successful completion of the MATH 152 course, we rephrased the question to as ask: does SI participation affect the chance of success, pass/failure in the course? Here again, the results are clear. After controlling for Incoming GPA and gender, success rates for SI participants are much higher than for non-participants. This was a substantial increase in outcome, in particular since the average grade of non-participants was a C and the average grade of SI participants was a B-. Furthermore, SI participants succeeded in the course at considerably higher rates (73% vs. 50%).

These findings confirm the preliminary results obtained in the Summary reports compiled each semester and the research undertaken at other universities (see Appendix A). They also validate generalization of the effectiveness of SI in non-majors Calculus courses. Reduced D, F and W grades corroborate claims of improved retention, for example see Martin & Arendale, 1992.

Discussion

The research validates that Supplemental Instruction is a working program at UNBC in the course, Calculus for Non-Majors. The SI sessions have provided an avenue for students to acquire the knowledge needed to succeed in the course through guided sessions where students have the opportunity to discuss content, practice problems, and prepare for exams. By attending SI sessions, students are being supported through innovative techniques that emphasize process-related learning through scaffolding and dialogue. These techniques are based on sound underpinning developmental theory that emphasizes the integration of socially meaningful contexts to create supported learning and the use of peers as facilitators to guide students through the processes required to succeed in the course. The SI leader, through facilitation, interaction, scaffolding, explanation, and breaking down of material into parts promotes learning in a socio-cultural context, similar to what Vygotsky (1978) and recent theorists such as Wells (2001a) and Gee (1996), envisioned.

Some students that may have withdrawn from post-secondary education as a result of mathematics requirements may now persist given their success in Calculus. Moreover, many of these students have developed stronger foundation skills in mathematics that will assist them in completing their program requirements. Some students will acquire an improved disposition towards mathematics as a result of their experience in SI.

Perceived Benefits of Supplemental Instruction

Although not tested in this evaluation of the SI program, there are other likely benefits to the SI program as implemented at UNBC. These are summarized in point form below. These possible benefits are categorized as students in the class, SI leaders, faculty, and UNBC itself.

Students in MATH 152

- SI participants have the opportunity to analyze, criticize, and communicate in the discourse of the discipline
- SI creates an environment where participants have the opportunity to connect to other students and the university
- SI participants form learning communities that carry over in to other course work
- SI participants are retained as a result of reduced D, F, and W grades

SI Leaders

- Develop valuable leadership skills
- Experience personal growth and empowerment
- Increase their understanding of the discipline they are working in
- Develop and experience sound teaching and learning pedagogies in their roles as SI leaders
- Become outstanding graduate students

Faculty

- Students are provided active learning opportunities
- More students are reaching the academic expectations for the course
- Students may perceive the course in a more favourable light and are very likely to be more knowledgeable in the discourse of the discipline
- Faculty and course ratings are apt to improve

Institution

- Improved retention trends - reduced D, F and W grades corroborate claims of increased retention
- SI provides students the experiential, collaborative, and active learning opportunities envisioned by UNBC as it moves forward in the academic visioning process (Penultimate Report: Phase 1 of the Academic Visioning Initiative, 2006)
- Students report more positive experiences at UNBC
- Increased satisfaction in the knowledge that UNBC students are graduating with the skill bases associated with their degree

Implications

The SI program has expanded into other mathematics courses at UNBC and has been piloted in Computer Science and Physics courses, supervised by the Math/Stats

Advisor (the first author). The LSC Coordinator, Lyn Benn, has piloted SI in Economics, Commerce, Geography, and Political Science courses with varying success. Although SI is not new at this institution, it has not been formally recognized or funded in any structured manner. As UNBC strives to meet recruitment and retention goals through new initiatives, it is time to recognize that Supplemental Instruction is a viable option for UNBC.

If SI is to continue expanding some issues need to be considered. This is essential to ensure full value is obtained by students, programs, and the institution when implementing a program of this magnitude. SI requires extensive coordination, supervision, and ongoing evaluation. This has placed enormous demands on staff at the LSC. It is recommended that UNBC consider staffing needs, in particular, the need for an SI Coordinator. Additional support staff may be required as well. An interim option may be to employ a senior SI Leader as an Assistant SI Supervisor reporting to the SI Supervisor. However, this particular option has been tried by LSC staff and although the Assistants selected have done an exemplary job, it is not always possible to find an experienced SI Leader able to take on the role. Another option may be to extend the LSC Advisor (Math/Stats) position from the current 10 month seasonal to a full 12-month position, thus easing some of the pressure that SI implementation creates in the fall semester. This would allow time for planning the fall SI program and evaluation of the previous year's SI program. The need for new or additional human resources creates a demand for appropriate funding. In addition, budget needs to be allocated for compensating SI Leaders and for expenses associated with providing SI. At UNBC, one SI Leader, offering three sessions per week, for one semester, costs approximately $700 -

$900. At present (winter semester, 2006) the Math/Stats Advisor is supervising 5 SI Leaders providing SI support in two Mathematics courses and two Physics courses resulting in a cost of approximately $4000 for the semester for SI Leaders alone. This cost is presently shared by the LSC and the Mathematics Program. Other universities in Canada have adopted the SI program and have resolved similar issues. For example, Thompson Rives University secured funding for its SI program through the College and University Enhancement Fund (CUEF). UNBC may need to explore programs such as CUEF to ensure funding for SI given the current budget restraints.

Criteria for which courses are to be supported should be developed. This is essential to ensure good use of funds. Many institutions allocate a budget for SI with final decision for courses to be provided support resting with the Deans and a Director. For example, the University of Guelph follows this type of structure. Based on criteria for selection set by the V.P. Academic Affairs Council (made up of all of the V.P.'s, Deans, and Chief Information Officer) decisions are determined as to which courses will be supported by SI and to what extent. Thompson Rivers University has an SI Coordinator who reports to the Division of Student Development. The SI Coordinator provides recommendations for course support with final decision resting with the Dean of the Division of Student Development.

Another consideration when looking at the role of SI Coordinator is reporting structure and departmental affiliation. For example, it is feasible that the SI training could be offered for credit as incentive to potential leaders. If credit were to be offered, then it may be desirable to have an SI Coordinator with a faculty designation thus meeting College Council requirements for credit coursework. The Thompson River SI

Coordinator position falls under the faculty agreement. The Carleton University SI Coordinator reports to the Director of the Centre for Initiatives in Education, which is an academic unit in the faculty of arts and social sciences. Another recurring problem is the space shortage at this institution and resultant difficulties scheduling classrooms for SI. Currently SI scheduling may take up to three weeks. Many student patterns are determined early in the semester. If students are to participate in SI it is important to begin the program early in the semester prior to the first failed assignment and prior to set patterns in student schedules/lives.

There are costs and considerations associated with offering SI. Nevertheless, based on the greatly increased grade point average and the substantially decreased failure rates, the authors strongly suggest that the Supplemental Instruction program at UNBC not only be continued but the funding be made available for the necessary expansion into other subject areas that warrant this attention.

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Appendix A

A Review of the Research on Supplemental Instruction

Blanc, DeBuhr, and Martin (1983) were among the first researchers to examine the effectiveness of Supplemental Instruction and to conclude SI participants earned higher course grades. In their study, Blanc et al. analyzed the impact of SI offered in seven Arts and Sciences courses to 746 students in 1980. The first analysis examined final course grades with three groups, an SI participant group (students who attended one or more sessions), a non-participant group (students who opted not to attend), and a motivational control group (students who wished to attend but were unable to). Subsequent evaluations indicated that motivation alone did not account for improved final grades (Blanc, DeBuhr, & Martin, 1983). However, assignment to a motivational control group may not assure that selected students were truly motivated thus creating some limitations in the study. Blanc et al. also demonstrated significant improvements in reenrollment for the following two semesters. A total of 73.2 % of SI participants versus 60.0 % of non-participant reenrolled two semesters later.

A further study undertaken by Kenney (1989) looked specifically at the impact of SI in two sections of Business Calculus, thus reducing the confounding factor of analysis across multiple disciplines. The Business Calculus course being supported through SI had consistently resulted in 30% of enrolled students earning D, F, and W grades. Kenney incorporated a control group for her study on SI impact. One section was provided support by a tutorial assistant (TA) using a content focus in sessions. The other section was supported by an SI leader trained in SI methods. Kenney established stringent guidelines of 60% attendance at tutorials and 60% attendance at SI – sessions that were closely supervised for correct SI practices. These controls minimized the motivational factor that may occur with SI. There were 84 students in the control group; 51 of these met the criteria, and 83 students in the SI supported group; 50 of these met the criteria. Kenney obtained College Board SAT Verbal and prior Mathematical scores for all students and compared the two groups. Kenney demonstrated there were no significant differences in ability between the two groups. Kenney then analyzed the mean final course grades of two groups and found significant differences in final grades. The scale for grades was: A = 4, B = 3, C = 3, D = 1, F = 0. The SI group earned a mean final grade of 3.0 and the control group earned a mean final grade of 2.43. Kenney followed up with more complex analyses to account for relationships between final grades and factors such as aptitude and prior mathematics achievement. Using multiple regression analysis, Kenney was able to establish that SI participation is a significant predictor of final course grades in the Business Calculus course. However, Kenney was the SI leader, resulting in a potential threat of experimenter bias in her research.

Kenny and Kallison (1994) planned another series of investigations into the effects of SI in entry-level Calculus courses in efforts to improve upon and add to the research. They established similar controls to Kenney's (1989) analysis but employed two different students to act as TA and SI leader. The SI leader underwent training in SI methods and the TA used traditional content-only focus. The same instructor taught both sections of the Business Calculus course leading to a common final exam. Kenney and Kallison reported that the students in the two different classes were equivalent with respect to ability and mathematics achievement levels. They also reported findings that indicate a significant difference in final grades (2.39 vs. 1.96). Kenney and Kallison's second investigation was virtually identical to the first but compared the performance of two classes of Engineering and Natural Science students. In this analysis, final grades were not significantly different. Kenney and Kallison conjectured that this result may due in part to the higher ability of engineering students. They completed further investigations to determine if lower ability students benefit more from SI intervention but encountered significant interactions limiting the scope of this study.

A more recent study undertaken by Burmeister, Kenney, and Nice (1996) demonstrated that SI participants earned significantly improved final grades in all three of College Algebra, Calculus, and Statistics courses. Their research contained data obtained from 45 different institutions in 177 mathematics courses for a total of 11,252 students. They reported that SI participants earned higher mean final course grades and experienced lower rates of withdrawals: algebra (2.21 vs. 1.98); calculus (2.28 vs. 1.83); and statistics (2.49 vs. 2.32). The scale for grades was: A = 4, B = 3, C= 3, D = 1, F = 0. A total of 3,631 students (32%) attended SI sessions with reported range of participation at sessions of 5% to 88%. Surprisingly, their study revealed that SI participants earned more D grades than expected but the rate of withdrawal from their respective courses was lower than their non-participant counterparts. Burmeister et al. identify some limitations in their research. For example, two questions they posed are: How closely did each of the institutions follow the SI model? Are the groups of SI participants similar from campus to campus? Unanswered questions about SI indicate a need for further analysis of the SI program.

The Center for Supplemental Instruction has been monitoring the effectiveness of SI since its inception in 1973. The Center compiles and analyzes data submitted by over

100 College and University SI programs annually. A review of the research (2000) used a quasi-experimental design to conduct a longitudinal analysis of SI effectiveness both in courses at UMKC and in course data submitted by other institutions. Again, the scale for grades was: A = 4, B = 3, C = 3, D = 1, F = 0. In all analyses in this study, a student was categorized as a participant if they attended at least one SI session. Chi-square analyses and t-tests were used to determine SI significance for improving course grades, decreasing D, F and W (withdrawal) grades, and improving retention trends. The first analysis included data collected over a 19 year period, in 525 courses, for a total of 19,962 SI participants and 31,368 non-participants. Chi-square analyses demonstrated significant differences in A and B grades with a reported 54.4% of SI participants earning A and B grades in comparison to 42.9% of non-participants. Similarly, the Center reported significant decreases in D, F and W grades amongst SI participants (20.2% vs. 33.8%). The Center also established an overall significantly improved mean GPA value (2.70 vs. 2.43). The Center replicated the studies using the criteria of attendance at 5 or more sessions and concluded there is statistically significant improvement with these comparison measures that favour the SI participants.

Similar results are reported by the Center for Supplemental Instruction (2000) on data collected from other institutions. The national data was provided by 270 institutions between 1982 and 1996, composed of 4,945 courses offering SI to over 500,000 students. In the first analysis, the courses were categorized as Business, Health Science, Humanities, Mathematics, Natural Science, and Social Science. The Center reported higher mean final course grades across all disciplines, a significantly higher percentage of A and B final grades, and a lower percentage of D, F and W final course grades. There were 815 courses in the Mathematics category with significant increases in A and B grades and significant decreases in D, F and W grades but a non-significant improvement in mean final course grades (2.17 vs. 2.11). A third study looked at the national data by course. There were a total of 143 Calculus courses supported by SI with significant differences in increased A and B grades, significant decreases in D, F, and W grades, and a significantly improved final grade (2.26 vs. 2.06). Similar results were obtained for 219 College Algebra courses: increased A and B grades (36.4 % vs. 27.9 %), decreased D, F, and W grades (37.5 % vs. 52.7 %), and an improved mean final grade (2.20 vs. 1.91). Similar results were demonstrated for courses in Finite Mathematics and Statistics indicating SI is effective in Mathematics courses offered at a variety of institutions nation-wide.

Discourse – A Theoretical Framework for Supplemental Instruction

"One does not have to be an educational researcher to agree with this: Mathematics is one of the most difficult school subjects" (Sfard, 2000, p. 1). Recent reform efforts by educators in the United States and Canada have attempted to move beyond direct instruction methods of teaching mathematics to the incorporation of discussion and meaning making in mathematics classrooms (Baxter & Williams, 1996; Chapman, 1995; Forman & Ansell, 2001; Wells, 2001b; Zack & Graves, 2001). Educators have made this move in response to societal need for individuals who are mathematically competent and able to contribute and achieve their full potential in our culture. To accomplish this goal, students must engage in activities in school that educate them in the values and practices that allow them to participate effectively in a democratic society (Wells, 2001a). They need to be given opportunity to develop personal initiative and responsibility, adaptable problem-posing and -solving skills, and the ability to work collaboratively with others (Dewey, 1916). This need has led to the recent research examining current education practices and teaching methodologies.

Two major learning theories have evolved during the course of this last century and have influenced current conceptions of knowing and coming to know (Wells, 2001a). The first of the emerging theories, Piaget's theory of "constructivism", challenged the idea that knowledge is passively acquired. The second theory, sometimes referred to as "social constructivism" (Wells, 2001a) is a Vygotskyan philosophy that argued learning occurs through social interaction in meaningful contexts (Vygotsky, 1978).

Wells (2001a) examined Piaget's theories of constructivism and ways of coming to know. Piaget, on the basis of numerous detailed observations and experiments with children, proposed that the learner's active, exploratory transactions with the environment gave rise to knowledge. In constructivist processes, if new material is compatible with what is known, then it is easily assimilated. On the other hand, if it is in conflict with what is known, the new knowledge will either be rejected or the existing knowledge will be transformed to accommodate the new (Wells, 2001a). Piaget's theory led to an emphasis on discovery and supportive learning rather than directive learning in education (Wells, 2001a).

Educators have moved beyond Piaget's emphasis on cognition and discovery processes, and now are also concerned with the cultural context as proposed by Vygotsky (Bunch, 1995; Daniels, 1995; Gee, 1996; Steele, 2001; Wells, 2001a; Zack & Graves, 2001). Vygotsky (1978) placed emphasis on the importance of culture and social interaction in accounting for individual development. Vygotsky argued that through engagement in culturally valued activities, and with the aid of other participants and of the mediating artifacts that the culture makes available, we become who we are. In these particular events, we adapt, extend, and modify both intellectual and material resources in order to solve problems. In other words, individuals come to learn the meaning of the culture by internalizing the meanings and being transformed by them as they learn to speak the language of the culture (Steele, 2001). Vygotsky's theory emphasized the need to develop communication and interaction for effective learning, and extends to mathematics education. If students are given opportunities to share their reasoning about ideas with others who in turn share their understanding, then culturally acceptable mathematics practices are established (Daniels, 2003; Gee, 1996; Steele, 2001). The SI Program was designed to provide an opportunity for models students, usually third and fourth year students, to share their understanding of the course being supported through SI and to provide an opportunity for discussion of the course.

Mathematics conversation can lead to a deeper understanding of the language of mathematics (Gallimore & Tharp, 1988; Gee, 1996; Steele, 2001; Vygotsky, 1976; Wells, 2001b). Through communication, ideas are reflected upon, refined, and remembered. As students learn to speak mathematical language they transform their thinking of the mathematical concepts. The mathematical language comes from the discourse of the culture, and the thought, or understanding of the concept, comes from the individual (Steele, 2001). Students, throughout their elementary and secondary school years, have traditionally been taught mathematics separate from other disciplines. Group work has seldom been encouraged in mathematics classrooms, and transmission-style teaching still tends to be the usual mode of instruction in the mathematics classroom. Teacher-centred instruction can provide the necessary skills to successfully complete a thematic unit such as functions. However, students rarely become competent in mathematical discourse through this type of instruction (Baxter & Williams, 1996; Chapman, 1995; Gee, 1996; Steele, 2001). The creation of mathematical knowledge can be improved by making meaning through processes of social interaction and language (Gee, 1996; Sfard, 2001; Vygotsky, 1976; Wells, 2001b).

Gee (1996) defines discourse as composed of ways of talking and listening, acting and interacting, believing and valuing, and using the tools of the discourse to become part of a particular social identity. He also claims that discourses are mastered by enculturation into social practices associated with the discourse -- lending itself well to Vygotskyian theory and to other theorists such as Sfard (2000), Linn & Kessel (1996), and Wells (2001a). For example, Sfard (2001) conceptualizes "knowing" mathematics as an ability to participate in mathematical discourse. Linn and Kessel (1996) emphasize the need to provide social support for learners. They state that, "All learning takes place in a social context, so the goal is to structure social interactions to support all learners" (p. 127). Gee (1996) states that enculturation is best accomplished through scaffolded and supported interactions with people who have already mastered the discourse. Scaffolding is a Vygotskyan concept and can be described as the various types of support that teachers/near peers need to provide in the process of supporting students as they learn to think. Scaffolding can be accomplished through directions, suggestions, and meaning making (LeFrancois, 1997; Linn & Kessel, 1996). Linn and Kessel also assert that scaffolding is a method to increase student success in mathematics. Furthermore, it is most effective if it involves tasks within the learner's zone of proximal growth

(LeFrancois, 1997). The zone of proximal growth is another Vygotskyan concept. It is the state of the individual's current potential for further intellectual development. Vygotsky believed that through the use of scaffolding, the individual may rise to further understanding. This may be accomplished through modeling, feedback, and dialogue (Gallimore & Tharp, 1988). However, mathematics continues to be taught using direct instruction methods, in isolation, with little or no connection to other disciplines. Very few people succeed in becoming conversant in mathematics and there is little opportunity for enculturation into the discourse of mathematics.

The goal of the SI program is to create an informal but structured social environment where students are encouraged to discuss course content, clarify and refine ideas, and become conversant with the topics at hand (Center for Supplemental Instruction, 2000). Further, it is the role of the SI Leader to create and support student interactions in the SI sessions, thus providing the recommended scaffolding for learning mathematics. The SI Program guidelines emphasize the need for practice in socially non-threatening environment where students can "safely" make mistakes, where open discussion is a means for clarifying concepts. Supplemental Instruction occurs without formal teaching, in a setting where students know they need to acquire the knowledge to do well in the particular course being supported and have the situation to do so.

Current theories on improving mathematical knowing, built on models proposed by both Piaget and Vygotsky (Gee, 1996; Wells, 2001a), indicate that the SI program guidelines are established on a solid theoretical foundation. Supplemental Instruction provides an environment for creating discussion and meaning-making in a socio-cultural context. The SI program at UNBC was designed to provide an opportunity for models students to share their understanding of the course being supported and to provide an opportunity for discussion of the course. The SI leader, through facilitation, interaction, scaffolding, explanation, and breaking down of material into parts promotes learning in a socio-cultural context, similar to what Vygotsky, and recent theorists such as Wells (2001a) and Gee (1996), envisioned.

Appendix B

Summary Data

Table 1.1

SI DATA: WINTER 2002 - MATHEMATICS 152 (Calculus for Non-Majors) Sections A1 and A2

GRADE (pt)	SI # students participating in 25 – 100 % of SI sessions.	(%) of class	NON SI # students who did not participate or participated in less than 25% of SI sessions	(%) of class
A+ (4.33)	11	23.4	16	10.6
A (4.00)	4	8.5	13	8.6
A- (3.67)	6	12.7	19	12.6
B+ (3.33)	3	6.4	8	5.3
B (3.00)	4	8.5	14	9.3
B- (2.67)	3	6.4	9	6.0
C+ (2.33)	3	6.4	7	4.6
C (2.00)	4	8.5	7	4.6
C- (1.67)	2	4.3	9	6.0
D (1.00)	2	4.3	18	11.9
F (0.00)	5	10.6	31	20.5
Total	47	100	151	100

Table 1.2

Summary Chart (WINTER 2002)

Total student enrollment for two sections of Mathematics 152	198
Number of SI sessions offered in term	232
Total number and percentage of students who attended SI	(43%) 85
Total contact hours of SI participating students	960
Mean number of sessions attended by SI participants	11
Mean size of SI sessions	4
Mean SI Participant Evaluation Rating of Helpfulness of SI (1=low,6=high)	5.8
Mean Final Course Grade of SI Participants	2.9
Mean Final Course Grade of Non-SI Participants	2.3
Percentage of SI students receiving a D or F grade	15
Percentage of Non-SI students receiving a D or F grade	33

Table 2.1

SI DATA: FALL 2002 - MATHEMATICS 152 (Calculus for Non-Majors)

GRADE (pt)	SI # students participating in 25 – 100 % of SI sessions. (6 or more sessions)	(%) of class	NON SI # students who did not participate or participated in less than 25% of SI sessions	(%) of class
A+ (4.33)	5	17	8	10
A (4.00)	1	4	10	13
A- (3.67)	5	17	9	12
B+ (3.33)	4	14	2	3
B (3.00)	6	20	1	1
B- (2.67)	3	11	5	6
C+ (2.33)	0	0	7	10
C (2.00)	1	3	4	5
C- (1.67)	0	0	5	6
D (1.00)	2	7	9	12
F (0.00)	2	7	17	22
Total	29	100	77	100

Table 2.2

Summary Chart (FALL 2002)

Total student enrollment for one section of Mathematics 152	108
Number of SI sessions offered in term	86
Total number and percentage of students who attended SI	(50%) 54
Total contact hours of SI participating students	413
Mean number of sessions attended by SI participants	8
Mean size of SI sessions	2
Mean SI Participant Evaluation Rating of Helpfulness of SI (1=low,6=high)	5.4
Mean Final Course Grade of SI Participants	3.0
Mean Final Course Grade of Non-SI Participants	2.2
Percentage of SI students receiving a D or F grade	14
Percentage of Non-SI students receiving a D or F grade	34

Table 4.1

SI DATA: FALL 2003 MATHEMATICS 152 (Calculus for Non-Majors)

GRADE (pt)	SI # students participating in 25 – 100 % of SI sessions. (8 or more sessions)	(%) of class	NON SI # students who did not participate or participated in less than 25% of SI sessions	(%) of class
A+ (4.33)	8	23	6	7
A (4.00)	0	0	4	5
A- (3.67)	4	11	3	4
B+ (3.33)	3	9	4	5
B (3.00)	3	8	3	3
B- (2.67)	1	3	6	7
C+ (2.33)	2	6	3	3
C (2.00)	3	9	4	5
C- (1.67)	2	6	5	6
D (1.00)	5	14	18	21
F (0.00)	4	11	29	34
Total	35	100	86	100

Table 4.2

Summary Chart (FALL 2003)

Total student enrollment for one section of Mathematics 152	121
Number of SI sessions offered in term	67
Total number and percentage of students who attended at least one SI	(50%) 60
Total contact hours of SI participating students	683
Mean number of sessions attended by SI participants	11
Mean size of SI sessions	10
Mean SI Participant Evaluation Rating of Helpfulness of SI (1=low,6=high)	5.6
Mean Final Course Grade of SI Participants	2.57
Mean Final Course Grade of Non-SI Participants	1.54
Percentage of SI students receiving a D or F grade	25
Percentage of Non-SI students receiving a D or F grade	55

Table 5.1

SI DATA: WINTER 2004 - MATHEMATICS 152 (Calculus for Non-Majors)

GRADE (pt)	SI # students participating in 25 – 100 % of SI sessions. (7 or more sessions)	(%) of class	NON SI # students who did not participate or participated in less than 25% of SI sessions	(%) of class
A+ (4.33)	5	9.43	9	8.91
A (4.00)	1	1.89	3	2.97
A- (3.67)	5	9.43	5	4.95
B+ (3.33)	5	9.43	8	7.92
B (3.00)	5	9.43	5	4.95
B- (2.67)	1	1.89	6	5.94
C+ (2.33)	6	11.32	10	9.90
C (2.00)	1	1.89	8	7.92
C- (1.67)	5	9.43	1	0.99
D (1.00)	9	16.98	14	13.86
F (0.00)	10	18.87	32	31.68
Total	53	100	101	100

Table 5.2

Summary Chart (WINTER 2004)

Total student enrollment for two sections of Mathematics 152	155
Number of SI sessions offered in term	111
Total number and percentage of students who attended at least one SI	(50%) 78
Total contact hours of SI participating students	946
Mean number of sessions attended by SI participants	12.1
Mean size of SI sessions	8.5
Mean SI Participant Evaluation Rating of Helpfulness of SI (1=low,6=high)	5.5
Mean Final Course Grade of SI Participants	2.1
Mean Final Course Grade of Non-SI Participants	1.8
Percentage of SI students receiving a D or F grade	35.9
Percentage of Non-SI students receiving a D or F grade	45.5

Table 6.1

SI DATA: Fall 2004 - MATH 152 (Calculus for Non-Majors)

GRADE (pt)	SI # students participating in 25 – 100 % of SI sessions. (7 or more sessions)	(%) of class	NON SI # students who did not participate or participated in less than 25% of SI sessions	(%) of class
A+ (4.33)	3	8.82	7	10.29
A (4.00)	4	11.73	1	1.47
A- (3.67)	3	8.82	5	7.35
B+ (3.33)	2	5.88	3	4.41
B (3.00)	3	8.82	3	4.41
B- (2.67)	4	11.73	2	2.94
C+ (2.33)	1	2.94	7	10.29
C (2.00)	5	14.71	7	10.29
C- (1.67)	0	0	4	5.88
D (1.00)	6	17.65	11	16.18
F (0.00)	3	8.82	18	26.47
Total	34	100	68	100

Table 6.2

Summary Data (Fall 2004)

Total student enrollment for one section of Mathematics 152	102
Number of SI sessions offered in term	61
Total number and percentage of students who attended at least one SI	(66%) 67
Total contact hours of SI participating students	791
Mean number of sessions attended by SI participants	12
Mean size of SI sessions	13
Mean Final Course Grade of SI Participants	2.5
Mean Final Course Grade of Non-SI Participants	1.8
Percentage of SI students receiving a D or F grade	26.5
Percentage of Non-SI students receiving a D or F grade	42.7