INCORPORATING SUPPLEMENTAL INSTRUCTION IN THE LEARNING OF MATHEMATICS: AN OVERVIEW

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ABSTRACT - The Supplemental Instruction (SI) Model has gained recognition as an academic enhancement and support program designed to assist learners in high-risk academic courses. It is a proactive and a non-remedial program, thus allowing students to obtain assistance before they encounter academic difficulties (Arendale, 2005). As such, the researchers realize the necessity to incorporate SI model in the learning of mathematics, as it always has been historically considered as one of the challenging subjects. The purpose of this paper is to discuss SI, a program that can improve the academic performance of the students in the area of mathematics and of equal importance, in improving the learning skills of these learners. The initial part of the paper provides the overview of SI, which includes the features, strategies, activities and benefits of SI. It then describes the successful SI programs currently implemented in institutions, both internationally and in Malaysia. Most importantly, this paper focuses on the SI methodology and presents alternative ways on how this original model of SI can be adapted for use at different levels of learners. Finally, this paper suggests some possible recommendations to guide institutions in meeting the diverse need of its learners to ensure success in the teaching of Mathematics through SI.

INTRODUCTION

The Supplemental Instruction (SI) model was originally developed by Deanna C. Martin in 1974, with the purpose of addressing the attrition rates for historically difficult courses at the University of Missouri-Kansas City. At the same time, it was aimed to improve the student grades and increase the graduation rates of students for that targeted courses, mainly for minority students in the school of medicine, pharmacy and dentistry (Martin & Arendale, 1993).

Martin & Arendale (1993) differentiate SI from the traditional tutorial practices by referring the latter as a medical model. The tutoring session is said to represent diagnosis of the students' academic problems based on their "prior history and diagnostic testing". Additionally, it is considered as a remedial program that students who actually need them are reluctant to attend. As such, the alternative model suggested is the S.I. As opposed to the tutoring session, this program is made available to all students and is not confined to only those with a "diagnosed problem" (Dawson, Lockyer & Ferry, 2007, p.4). Additionally, the utmost important of this S.I. program is that it has no remedial stigma attached to it.

SI is a proactive and non-remedial academic support program which targets high-risk courses (Arendale, 2005). SI provides assistance in a regular-scheduled basis and out-of-class study sessions that begins during the first week of classes. According to Martin, Hall & Arendale (1993), the features of SI can be summarized as follows: 1) targets high-risk courses instead of high-risk students, 2) uses peer-assisted study sessions 3) offers assistance to everyone in the course, 4) student participation is voluntary; and 5) implements sessions in small groups.

It is important to note that SI model identifies high risk courses instead of high-risk students. This indicates the proactive and non-remedial concept of SI model. The term high risk courses depends on the institutions and researches; however, the norm is defined as courses having 30 percent or more for D grades, F grades and withdrawals. These courses are normally the prerequisite courses or introductory courses that students must passed in order to enter a program or to be allowed to continue to the subsequent level (Arendale, 2003).

As for activities in SI, this model involves participation of students in 1) comparing notes, 2) discussing readings, 3) developing organizational tools; and 4) predicting test items. With such activities, the students will be able to learn how to integrate both the course content and the learning strategy while at the same time encouraging collaboration with one another. In other words, SI integrates "what to learn" with "how to learn" combining with social interaction (Dawson, Lockyer & Ferry, 2007).
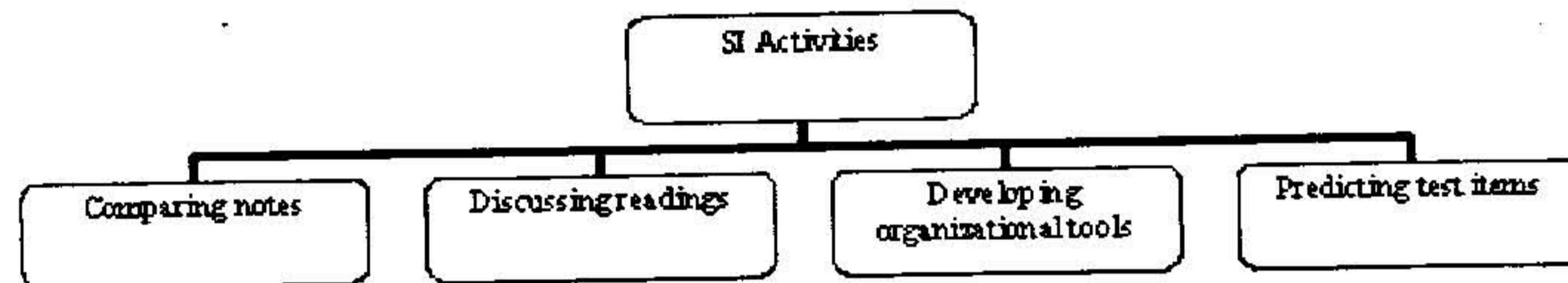

FIGURE 1: Activities in Supplemental Instruction

S.I. conceptual framework is based upon many theories such as cooperative learning, collaborative learning, constructivism, cone of experience, academic and social integration and lastly, zone of proximal development. Phelps & Evans (2006) opined that combination of Gardner's theory, Tinto's theory, Tatum's theory produce the term climate of achievement which needed to be created for an effective supplemental instruction program. In constructivism and zone of proximal development, these two theories form the basic of S.I due to the fact that it is the learners' comprehension of contents combined with assistance from peers or collaboration that produce successful results.

Jean Piaget's ideas called "constructivism" are based on observation that students must construct their own knowledge in order to be able to understand and use it. According to Vygotsky (1978), social interaction is fundamental to the development of the cognition. He added that as for the theory based on Zone of Proximal Development, there is a set of things that each learner can do independently and a set of things that the learner can only do with the assistance of more capable others. In SI context, the latter, or the second zone represents the things that the learners can perform with the assistance of group members and SI leaders. These collaborative activities form the second zone because the students would not be able to do without the help of "more capable others" (Dawson, Lockyer & Ferry, 2007).

OVERVIEW OF SUPPLEMENTAL INSTRUCTION

Many learners are not prepared for higher level of studies and do not know how to study (Martin & Arendale, 1993). According to Hodges (2001), institutions now turn to supplemental instruction (SI), one of two forms of academic assistance besides tutoring to help students succeed in their studies. This S.I. strategy involves four main persons and comes in various forms (Arendale, 2003).

The SI model involves four key persons:
1. SI Supervisor - A trained professional who is responsible for identifying the targeted courses, gaining faculty support, selecting and training SI leaders and evaluating the programs.
2. Faculty Members - Academicians of the targeted courses selected for the SI programs. They must support SI services for the class and select the SI leaders based on the content competency.
3. SI Leaders - These students have been approved by the course instructor and usually model "good student" behaviour. They are course competent and are trained in learning strategies as well. They attend all class sessions and do all assigned work. They are not tutors and they are not "re-teaching" the lecture material: their main responsibilities are to facilitate discussion and prepare activities for the students (Dawson, Lockyer & Ferry, 2007).
4. Students - These are students who volunteered to participate in the SI sessions.
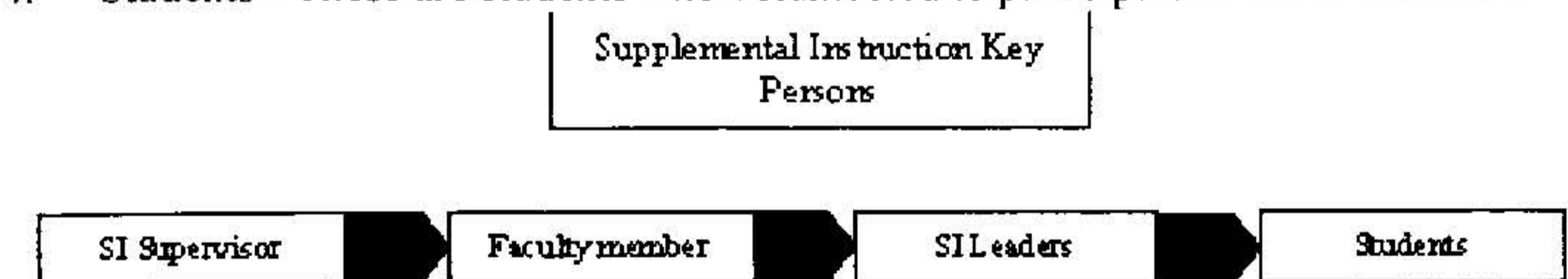

FIGURE 2: The Four Key People in SI

VARIOUS FORMS OF SUPPLEMENTAL INSTRUCTION

Four various usage of supplemental instruction for different kinds of learners are provided below as examples. The initial one involves secondary school learners provided with the normal face-to-face sessions conducted in Kansas City, an inner city school with

diverse racial background. The second one explains the video supplemental instruction: interactive video courses for undergraduate students in Kansas City. Thirdly, the example involves the undergraduate students in one of the higher education institution in Malaysia with the use of supplemental instruction face-to-face sessions. Lastly, the example shows the continuous online coaching support that act as S.I. for the online distance learners in Malaysia.

(i) Secondary School Learners

Introduction - According Martin, Hall and Arendale (1993), the SI model was adapted to be used at the high school level for English and History classes for the ninth and tenth graders (14 and 15-year old students). For this purpose, two adaptations were made here: firstly, the students from these classes were selected as they had difficulty coping with those two subjects and secondly, the students' participation in SI was mandatory as they were also the participants of another project that enable them to be eligible for free tuition fees, boarding for college or university of their choice and others.

Implementation - For the S.I. to be implemented in the secondary school, the SI leaders were selected from among the college students nearby the school area. These students were recommended and given approval by the course instructor. Once they were selected, they were paid and trained for about one week before they started going to the high school. During daily staff meetings, additional training was also provided. The SI leaders attended the classes and took notes. The purpose was for them to be knowledgeable on what went on during class sessions and equally important, to show to the students that they were good role models by attending the classes consistently. At the beginning of the program, to show support to the leaders, the SI supervisor accompanied the SI leaders to the class lectures, they planned together the SI sessions and the supervisors also accompanied the leaders to their sessions. As time progresses, the SI leaders carried on with the activities on their own.

To summarize, the SI sessions were conducted as below:
1. Two to three sessions a week
2. One session lasted 50 minutes
3. The average number is 5 students per group with the maximum of 10 students per group
4. SI sessions schedules throughout the day

(ii) Undergraduate - Video courses with Supplemental Instruction (VSI)

Introduction - This VSI provides alternative mode of instruction that can be used on either the university campus or in places where access education is limited. Historically, this mode of instruction was implemented by the University of Missouri-Kansas City for their medical students who had failed the basic sciences comprehensive examination in their second year. However, the video-based program was also made available for other medical schools outside Kansas City at that time.

Implementation - For these S.I. video courses, a regular course instructor's lectures were video taped. The course was conducted for 7.5 hours per week as opposed to the regular course requirement of 3 hours lectures per week. Along with the manuals provided for facilitators and students, the trained facilitators use the video lectures as a tool to guide the students (Martin & Arendale, 1997).

The advantage of this session compared to the regular lecture was that the video tape was stopped at key places for clarification and practice. The video lectures could be stopped frequently for the students to reflect on the content that was being delivered. They could use the "pause" moment to think and have some discussion with other students before continuing. Martin and Arendale (1997) stated, "This technology enables the student to alternate between the professor's lecture and the silence in which to consider the meaning ....the reflective time allows the student to form questions, observations, and opinions" As for assessment, since this was the video course, the professors prepared the exam questions and did the grading however, the facilitator oversaw the learning that took place.

This latest VSI Program was changed to suit the target and purpose of the program. The table below summarizes the amendments made compared to the earlier video course:

Earlier Video Program	Video with SI Program
Preview of the vocabulary and the main topics to be covered in the lecture	Get undergraduate professor to deliver entire course in the video studio
Process the videotaped – stop video tape for students to clarify presentation or to ensure students are progressing well	Students must combine 3 to 4 hours of course and 3 hours of extra study skills courses (total = 7.5hrs)
Review the videotaped lecture	Students provided with a videocassette recorder, a monitor, a blackboard and a facilitator.
	Professor administers exams to the regular course and the video-based course students on the same schedule and same grading standards.

(iii) Undergraduate

Introduction - As with other SI Programs implemented in other institutions, the Peer Assisted Study Sessions (PASS), a type of S.I., was conducted in one of the private institutions of higher education in Malaysia to assist students in their transition to tertiary courses and simultaneously, to retain these students in the programme (Subramaniam, 2007). This program was offered for mathematics course which was considered as a risk subject in this institution for students pursuing Hospitality and Tourism studies.

Implementation - According to Subramaniam (2007), PASS was conducted for five weeks for one-hour per session, per week. The peer leaders, who acted as mentors, were

selected from the seniors, either second year or third year students who had performed well in the selected mathematics course previously and they were also recommended by the lecturers. These students conducted the entire non-compulsory sessions for their juniors. Similar to other institutions which implement SI, these peer leaders attended training on how to facilitate the sessions.

(iv) Undergraduate – Distance Learners in Malaysia

A research study was conducted to evaluate the effectiveness of the face-to-face pre-instructional support and online coaching on learning mathematics in a blended learning environment for Open University Malaysia (OUM) learners (Sheikh, Ng & Abtar, 2008). The purpose was to increase the learners' readiness in learning mathematical subject via open and distance learning mode. As such, a one-day workshop was conducted to provide pre-instructional support to the volunteered OUM learners. The research continued throughout the whole semester where learners attached one tutor (Tutor R) were provided with additional supplement coaching (SI) via online and another tutor (Tutor S) only provided normal face-to-face coaching as per lesson guide.

Apart from the normal tutorial session, Tutor R was also involved in carrying out the online SI whereas Tutor S involved in just carrying out the normal tutorial session based on the standard module supplied. At the end of the semester, students' results were analyzed and compared with results of those students who did not attend the workshop. Comparison of results was also made between students who were under the workshop instructor who carried out the S.I. and students under the normal coaching tutor.

FINDINGS OF RESEARCHES

Generally, many researches conducted on SI have shown significant results where it does influence grades and even retention (Phelps, 2005 & Doty, 2003). Phelps and Evans (2006) stated that many studies suggest that SI improves the grades of minority, non-traditional, low-risk and high-risk students. All these studies collaborate with Tatum's ABC Theory (Affirm identity, Build community and Cultivate leadership). Tatum (2000) asserts that affirming identity, building community and cultivating leadership are important factors when creating a climate of achievement. All these factors form the foundation concept of S.I. and thus, produce to be an effective learning strategy.

According to the researches, the S.I. adopted in the high school showed favourable results. The grades for the English course improved tremendously with higher percentages of grades A and B, simultaneously, the percentage of F grades became lower (Martin, Hall & Arendale, 1993).

For the interactive video courses, given that all students were enrolled in the same large lecture class with similar lecturer and tests, the analysis of data suggested that the Video Supplemental Instruction (VSI) students obtained higher final course grades than the non-VSI students. Additionally, results also showed that the VSI students earned higher final grades despite their lower entrance examination results compared to the non-VSI students (Martin & Arendale, 1997).

For the research conducted by Subramaniam (2007), the findings indicated that this program proved encouraging success rate. The top two highest students in the course were students who had attended the program. Additionally, 50% of the students who sat for the examination passed with more than half obtained 80% and above. However, the researcher's concern was with the other 50% of the students who had failed the examination and the majority was international students. Therefore, the researcher concluded that another factor needed to be considered; international students' participation and therefore, their proficiency in English.

For the research conducted in Open University Malaysia, the workshop conducted as part of the orientation program and the extended coaching via online which acted as supplemental instruction (SI), have proven to provide academic assistance to these learners to succeed. When comparing workshop participants for both tutors, the findings showed that different tutors produce different effects on the learners' results. The workshop participants attached to tutor who has extended coaching via online (supplemental instruction) produce better results compared to participants who are attached to tutor who used normal coaching (Sheikh, Ng & Abtar, 2008).

The SI concept, which involved face-to-face coaching by experienced learners, can be expanded into online forum with proper software and coaching and turned into a collaborative learning experience. Ng and Wagner (2007) in their research found that the participation of learners increased from 64% to 84% (Abtar, 2004) with the introduction of Collaborative Online Learning (COL). The learner's average hit rate is generally higher for COL courses compared to non-COL courses. Fadzil (2005) has proposed that one of the critical success factors in developing online learning is the human factor where the new learning culture must be learner centered, interactive and engaged in a collaborative online learning. In their studies, Dawson, Lockyer & Ferry (2007) has developed an online mentoring model that uses technology to provide support to the geographically dispersed SI leaders.

CHALLENGES

What are the challenges faced in conducting supplemental instruction program?

For any program to be implemented there would definitely be problems that need to be overcome. Many (Dawson, Lockyer & Ferry, 2007; Martin & Arendale, 1997; Subramaniam 2007) have concluded that the main challenges in implementing supplementary instruction program are:

- Attendance and sustenance of the students because this is based on voluntary participation
- Appropriate schedule to accommodate the session
- Retaining of the SI leaders
- Support from the Faculty Member.

RECOMMENDATIONS

The supplemental instruction program can become a success if it is being implemented carefully. To ensure this, many aspects need to be considered in order to adopt the supplemental instruction. The following factors are some suggestions that involve the key persons in SI program:

SI students:
1. Who are our target group?
2. Is it applicable to have the sessions 3 times a week?
3. Is there available common time for the program?
4. How do we get the students to attend and retain them for the whole duration of the program?

SI Leaders:
1. Who are the SI leaders?
2. Do we have alternative SI leaders? Should we consider adult volunteers? Parent volunteers or others persons that can serve as SI leaders and supervisors?
3. How can we pay the SI leaders?
4. Should online mentoring model be considered because of the geographically dispersed SI locations and the availability of technology nowadays? (Dawson, Lockyer & Ferry, 2007)

Faculty Members:
1. Can we get the full support from the faculty member?
2. Is the program "official" and integrated in the course? (Subramaniam, 2007)
3. Can we get full support from the administrators?

As we can see from the examples described in this paper, among the adaptations that have been made were:
1. The usage of video supplemental instruction for remote areas
2. Students participation in SI sessions were made compulsory instead of voluntary basis,
3. The number of sessions conducted per week varied depending on the researcher and participants

As for the activity conducted, it needs to be emphasized that the roles of the SI leaders are neither to teach again nor to answer questions on the content taught by the lecturers. On the other hand, the responsibility of the leaders are to ensure that the session include activities that involve students' participation on the discussion of the course content.. It has been suggested that an effective strategy is to plan session that consists of three parts: a 10-minute warm-up activity, a 30 minute group interaction activity and a 10-minute closing activity (Phelps & Evans, 2006).

As for the researches, it is also important to note that research conducted should include the qualitative aspects besides the quantitative data. Most of the current researches on SI produce results that are based on outcome measures such as examination results. It

is suggested that relevant qualitative research inquiry include factors that motivate and sustain students to seek assistance in SI initially. Additionally, another aspect would be the kind of learning experience obtained at the end of the program. The information obtained here would be useful for the researchers to improve their current implementation of the program and also for beginners of this program.

CONCLUSION

In order for any organization to adopt the SI model, adaptations have to be made. The initial idea in introducing SI was for medical students to improve and reduce the failure rates of the science subjects and at the same time to increase their retention rate. However, many researches have used the model for various courses by modifying the initial program to suit the target group.

As educators, we need to continuously explore and improve our teaching skills that can provide support to our learners' performance and retention capability. Our focus now should shift from teaching to improving the student learning in achieving the optimal learning. Supplemental instruction enhances understanding, learning and thinking skills due to the fact that it enables cooperative and collaborative learning approach that forms the basis learning foundation (Subramanian, 2007). More than 30 years into practice, the supplemental instruction, thus far, has "shown promise as a mechanism for establishing a climate of achievement for at-risk learners" (Phelps & Evans, 2006). Furthermore, as reviewed by Thibodeau in Stone and Jacobs (2007), "It is estimated that across hundreds of institutions and thousands of courses, SI participants earned an average final course grade roughly 15 percentile points higher than non-participants, usually regardless of student characteristics such as standardized tests scores, rank in high school class, age, gender, ethnicity, and work responsibilities". As such, the effectiveness of this student support program which has been accepted and implemented widely now is truly remarkable.

In summary, Thibodeau (Stone & Jacobs, 2007) aptly defines the Supplemental Instruction program as:

> ...a system of course-linked student support intended to improve grades and student retention. Student leaders plan and facilitate weekly study sessions for students enrolled in "historically difficult" courses. They engage the students in active and collaborative learning strategies to review the weekly course material. .....They focus on getting participants to use effective study strategies to review the week's work with their peers.

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