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Research paper

The Effect of Supplemental Instruction on Educational Accomplishments and Behaviors of Organic Chemistry Scholars

Oliver Barth
Johannes Kepler University Linz, Austria

A R T I C I E I N F O

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**Corresponding Author:*
Oliver Barth
Barth215782@yahoo.com

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A B S T R A C T

Supplemental Instruction (SI) is proved to be an effective application in universities and colleges around the world. SI is considered to decrease attenuation and enhance educating and accomplishment rate amongst pupils who took part in the study. We have applied SI on Organic Chemistry I lessons to support pupils' engagement with acquiring the subject and information of Organic Chemistry, that is thought to be a tough and attenuating course. The goal of this study is to scrutinize the effect of SI addition in a big lecturing type Organic Chemistry class and meanwhile supporting scholars' education and accomplishment in the mentioned class. The aim of the present study is to inspect if SI affects the scholars' educational accomplishments, behaviors and educational capabilities. The tentative scheme is grounded on an experimental-like method that contains a survey of open-ended and Likert-scaled questions which was given to SI scholars and their scores have been compared with the scores of scholars who were not in SI plan. Results show that adding SI to Organic Chemistry lessons will have positive effects on scholars' behavior towards the subject and involvement in the class, assist the scholars to grasp the subject and information better, enhance scholars' abilities to solve the problems, and can be helpful in enhancing scholars' accomplishment, success and education. SI scholars responded with an average of 81% on overall passing, where non-SI scholars had an average of 50%. SI scheme has delivered a special and personalized educational experience for scholars which ended in an improved conceptual perception.

Introduction

Organic Chemistry is a unit that is needed for many science, engineering, pharmacy and pre-health courses. The course is very demanding which may discourage scholars to continue in science. Most of the scholars are afraid of the course and think of it as an obstacle in their academic path. The fact that it is famous as an obstacle comes from scholars' understating of it; how professors talk of it and that its teaching methodology focuses on talented scholars (Salame 2021). Classes with further scholars than 100 are considered as big ones (Malm, Bryngfors et al. 2012). The majority of colleges and universities are offering Organic Chemistry units as big classes to be cost efficient. This course has the features of a high risk or tough unit since it needs noticeable portion of studying, exams which aims higher cognitive levels, intentional participation and because of the size of the class, very

few interaction with the teacher (Arendale 1994).

The SI scheme has first launched at Missouri university in Kansan city to tackle the high attenuation rate for some units. Since it resulted in enhanced scores and maintenance, it was applied on other units as well (Burmeister er al., 1996). SI is a collaborative learning method which is a component of the unit. It is a model of academic assist grounded on peer-helping education. SI is applied on 29 countries and 1500 institutions (Martin and Arendale 1992). The plan is aimed at hard lessons which had 30% or more of D,W and scores (Bronstein 2007). It is normally planned as a workshop which assists scholars education through defeating problems in a cooperative learning set which is directed by a peer teacher (Martin and Arendale 1992). The scheme has also helped increasing maintenance and graduation rates beside enhancing scholars' scores (Congos and Schoeps 1993). Scholars have found SI to be effective in enhancing education and a successful teaching method (Ning and Downing 2010).

Colleges have utilized SI in order to grow maintenance and achievement rates in difficult lessons which show high rates of attenuation (Harding 2012). The education department in USA has acknowledged the SI plan as a valuable plan for repetition in post-secondary education associations (Forester, Thomas et al. 2004). Students of accounting have found SI effective to enhance the overall scores and reduce failure, attenuate, and disavowal scores (Etter, Burmeister et al. 2000). The results of their study proved that SI enhance scholar's maintenance and educational success. Scholars who took part in SI scheme had better grades than their colleagues, enhanced and team work and interaction abilities, better maintenance rates and improved motivation (Bowles, McCoy et al. 2008) Many researches have concluded that SI is an efficient methodology to enhance undergraduate educational successes (McGuire 2006).

Scholars who took part in SI plan join classes that assist them to correct their educational procedures in order to turn into effective learners according to their team communication and social interdependence that enhances cognitive growth (Paideya and Sookrajh 2014). Scholars of SI effectively participate the learning procedures compared to non-efficient presence in old lecture type classes (Hurley, Jacobs et al. 2006). Furthermore, as scholars are put into groups, get more involved and take advantage from other students in the group (Dion, Fuchs et al. 2007). SI scholars learn lessons collaboratively, debate the lesson notions and their association and get involved in the procedure of solving problems.

The SI coaches are chosen out of a group of scholars who have finished their lessons and got great scores. These students are taught to be peer leaders and managed by the course teacher. These leaders are not allowed to give lecture or solve problems. They assist debates, group tasks, and problem solving with other colleagues. Scholars of SI act collaboratively to discuss the problems and solve them with the help of each other (Bodner and McMILLEN 1986). Moreover, SI leaders inspire involvement and oral debates among other students in a group (Sookrajh and Paideya 2010).

Studies has shown that joining SI will affect scholar's overall educational accomplishments in the first year and they will obtain learning methods and potentials which results in enhanced educational successes other lessons (Malm, Bryngfors et al. 2010). As Bowles and colleagues stated, scholars who attended the SI plan in their first year enhanced their possibility to finish studying on time (Burmeister, Kenney et al. 1996). Scholars realized that students who attended SI in their first year gained better marks than those who did not attend (Malm, Bryngfors et al. 2011). SI attendance gained higher marks than the non-attendant ones, even if they were less likely to have educational achievement according to their college admission standards (Gafney and Varma-Nelson 2008). Study information show that SI plan nurtures learning habits and improve inspiration and learning of hard subjects (Grillo and Leist 2013). Furthermore, pupils who attended SI had better short and long term results comparing to non-participated students (Ogden, Thompson et al. 2003).

SI plan was conducted for four times a week when Chemistry lesson was due. It would be much easier for pupils who have a full schedule to participate in the SI plan. We have intended the SI classes to let students work with each other, debate the subjects, find out misunderstandings and solve problems (Rath, Peterfreund et al. 2007). It must be noted that through 2020's spring when Covid-19 was already out, SI was transferred to Blackboard Collaborate Ultra and the participants enhanced that can be because of scholars feeling concerned and dealing with the subject issues.

The SI classes were proactive in order to inspire scholars to participate. SI timings were set through the first week of sessions so that scholars have support before the amount of lessons they had to learn gets big. SI participation is by choice and pupils who are dealing with the lesson are specifically inspired to take part. Students who finished Organic Chemistry with great marks and had achieved high academic successes were hired as the SI coaches. SI coaches are educated PLTL managers who scheduled their meetings to inspire and ease pupils' communications, assist, and involvement. SI leaders have received education as PLTL managers that involve assisting pupils to enhance their educational abilities. Answers and lectures are not provided by SI

coaches. They simplify learning and letting pupils to debate and argue about the problems. SI coaches act collaboratively to develop their educational potentials and stay away from rote-learning (Ausubel, Novak et al. 1968).

The goal of the present study is to inspect the effect of SI scheme in a large class of Organic Chemistry with lecture formant and meanwhile assist pupils learn and become successful in the class. The present study is unique since there have been no study of SI in Organic Chemistry up to the present time. Moreover, we aimed to inspect if the at-risk pupils can also take advantage of this method. It also needs to be noted that the course has three sections: the old big-lecture section, recital section which is performed in PLTL type, and SI. PLTL involves pupils in solving problems and simplifies debates or materials (Gafney & Varma-Nelson, 2008). Where PLTL and lecture are mixed as a fix section of the lessons for all pupils, SI is by choice and utilized to help at risk and challenging pupils in the course.

1. Is SI effective in attendants' educational successes?
2. How do SI attendants feel and behave toward their experience?
3. Is SI effective on pupils' knowledge and capabilities?

To make a good assessment of the effects of mixing SI with Organic Chemistry, a quasi-tentative method was utilized to evaluate the impacts of it on pupils. The information were obtained from a five-point Likert questionnaire and open-ended questions which was given to the pupils. Furthermore, the marks received in the course were evaluated to compare SI and non-SI attendants. The study was in accordance and authorized by the Internal Review Board (IRB). We also need to mention that although the study was voluntary, 90 pupils out of 133 SI attendants finished the research.

In order to understand the information, an average was taken from the participants' answers for each problem. Each open-ended question had a rubric and an average was obtained from the participants' answers. The information gained turned into graphs. Pie charts were designed for one question and according to the format and percentage of the answers.

Although we attempted to get more pupils attending the SI classes, 133 pupils joined the program. 81 percent of SI attendants obtained passing marks where non-SI pupils had a number of 50 percent.

The information shown in Chart 1 demonstrate that pupils think SI has assist them enhance their problem solving capabilities, their Organic Chemistry problem-solving capabilities, their understanding of Organic Chemistry materials discussed in the lectures, and strengthening the subjects learnt in the class. Moreover, the information obtained from pupils demonstrated that the pupils' have found SI coaches very obliging and that SI scheme has given them a chance to study problems out of class format. Pupils thought that SI had worth the time and energy they have put in and was totally useful and helped them enhance their marks. At the end, their overall engagement with SI was completely optimistic. It should also be noted that the questions in the format of Likert had an average of more than 4.73 for all questions.

Table 1 shows the information according to open-ended questions. This chart demonstrates that pupils think SI has assist them to comprehend the materials of Organic Chemistry much better and they are likely to recommend it to other pupils. The definition of SI in their mind was very good.

Figure 1 is a pie figure that demonstrates the advantages pupils obtained when engaged with SI. 48% of the pupils enjoyed the amount of time used for solving problems, 19% mentioned the significance of personal care they were given throughout the SI program, 15% cited the good speed of the program, that is mostly opposite to lectures that need to discuss many topics, and 18% appreciated the significance of group work, even though they are engaged with social education. Scholars emphasis on the significance of social education and involvement in SI program that permits building physical, safe, and cognitive environment for chemistry lesson (Paideya & Sookrajh, 2014).

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The received information show that pupils underestimate the significance of team work. Pupils worked together to solve the problems and the SI leaders assist to simplify the learning procedure. The data obtained by the scholars implies that once pupils elaborate a subject with their own voice and get involved in debates with other pupils, they will have better comprehension of stoichiometry (Paideya and Sookrajh 2014). The pupils were employed by faculty members, PLTL coaches, SI coaches, and blackboard who had problem in learning the concepts and are considered as at-risk pupils. A problem that we faced when applying SI in Organic Chemistry was that we weren't able to find more pupils to be persuaded to join and participate in SI plan which can be sourced from pupils not being interested, inadequate inspiration, or lack of interest in the philosophy of SI. The pupils that we employed beat the ones who did

not attend SI plan. Data on nursing pupils and SI demonstrates that effects on at-risk pupils' accomplishments is evident (Hensen and Shelley 2003). Moreover, researches on SI in introductory biology demonstrate that this is efficient for at-risk pupils and assists them in enhancing academic successes and improving academic behaviors (Moore and LeDee 2006).

Table 1. Questions and averages for the answers for the Likert-type questionnaire

Question	average answer from Respondents
SI has assisted me to enhance my Organic Chemistry capabilities	4.89
SI has assisted me to comprehend the problem-solving methods better	4.77
SI coaches could recognize my weak points in Organic Chemistry and assisted me to enhance them	4.72
SI inspired me to study extra beyond class time	4.81
SI assisted me to comprehend the concepts of Organic Chemistry, discussed in lectures, better	4.84
SI assisted me to comprehend Organic Chemistry content better	4.82
SI was valuable enough for the time and energy that I spent	4.81
SI had advantages for me and helped my enhancement in marks	4.76
Solving problems throughout the SI plan assisted me to comprehend and strengthen the subjects learned in the class	4.79
short-answer responses	
Do you think that SI assisted you to comprehend the subjects in Organic Chemistry better than if you had to do yourself?	4.88
Are you willing to recommend SI to other pupils? Why?	4.91
Please explain your overall engagement with SI.	4.87

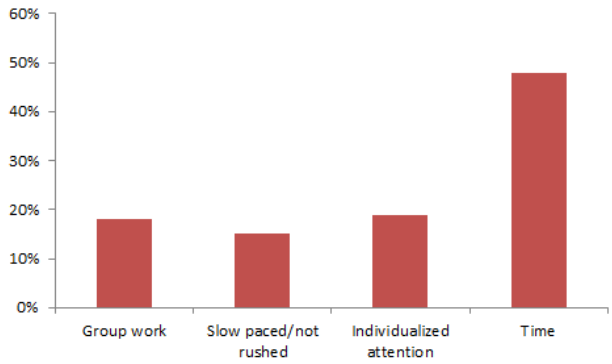

Figure 1. Pie figure of SI's helpful features for pupils

The expenses of having an SI meeting at City College is around 8 USD for each pupil which not high. This price is believed to be very low for solving the problems of attenuation and failing rates of the old lecture format classes. SI is a cost efficient plan in which pupils work together to debate the lesson materials and subject and the problems that assist them enhance education and accomplishment chemistry (Lundeberg 1990).

The outcoming statistics demonstrate that pupils had a good experience and their educational successes were enhanced. This may be due to the fact that working together has eliminated an amount of their stresses when learning a difficult subject and also built comradery withing the attendants. This idea is backed by one investigation at minimum in which the statistics demonstrate that SI has a positive effect on pupils' learning experience and raises their involvement in learning the subject (Bengesai 2011). SI gives pupils' the chance to improve their conceptual comprehension of the lesson's materials along with their learning and studying habits. SI attendance is by choice and it has positive effects on academic accomplishments in Physical Chemistry (Bengesai 2011).

We had 14 session of SI throughout one semester. Most of the attendants participated in almost all of the meetings. A few of the pupils attended less than others. In fact, some of the pupils attended only one meeting. However, the statistics of

those who attended only one meeting were not included in the present study. Scholars have realized that pupils who participated the least amount of meetings also beat the one who did not attend the meeting at all (Carlsen-Landy, Falley et al. 2014).

The attendance rate was around 33% which 133 of 400 pupils that were invited, although we made many attempts to get more pupils involved in the program. It also needs to be mentioned that CCNY failure rate, the pupils who do not get ABC scores, is around 50%. Aside from the fact that SI attendance will significantly raise pupils' academic accomplishment, a lot of pupils are still unwilling the participate (Arendale, 1994). Scholars has mentioned low attendance rates, same as ours, at CCNY where the outcome was also the same in that SI attendants received better marks than non-SI attendants (Altomare and Moreno-Gongora 2018).

A few obstacles of the present research are that its data is obtained from a city in which pupils have various backgrounds and we did not consider in our analysis. Also collecting information about pupil education is very difficult to study. This may be hard to get adequate information and ideas on pupils' education and comprehension of Organic Chemistry from just a questionnaire. Further research and detailed interviews can build a logical study in the future. One other issue is that pupils voluntarily choose to attend SI and this shows that more inspired pupils attend the SI.

This should be mentioned that SI attendants, who participated in SI sessions since they had problems in the course, had an average of 81% overall pass in comparison with 50% for non-SI pupils. The same results were observed in another study in which SI attendants showed a passing rate of 79% in Calculus course in comparison with 39% for non-SI pupils (Malm, Bryngfors et al. 2011). The results demonstrate that pupils who attended SI meeting beat the non-SI pupils and they have had a good experience with SI that could be because of more inspiration for SI attendants. It is also backed by other studies in which the SI attendants kept beating non-SI pupils and found their experience efficient in crossing the barriers in the course (Kalil, Jones et al. 2016). Forester and co-authors stated that medical pupils who attended SI, received better marks and levels of gratification which shows similarity with our outcomes (Forester, Thomas et al. 2004).

SI attendants earned more A, B and C scores in comparison with non-SI pupils and it resulted in adding up the success rates for SI pupils. It is backed by various researches in which the researchers realized that SI pupils gained better percentage of A and B marks and lower percentage of D, W and F marks in mathematics, biology, physics and chemistry (Hensen and Shelley 2003). It is also stated that SI pupils received less admission grades than non-SI pupils.

The information from another research demonstrates that SI attendance will considerably improve marks and passing rates. It should be mentioned that this research is considered for managing non-academic elements (Congos and Schoeps 1998). Chemistry lessons by one teacher were compared in an investigation and the results showed that the class with SI applied on, had better marks (Carlsen-Landy, Falley et al. 2014). At the end, studies on biology lessons demonstrate that SI pupils received better overall marks in comparison with non-SI pupils (Congos and Schoeps 1993). Such results are the same with the statistics and facts that we had and it shows that pupils' educational accomplishment is affected by SI participation.

The results imply that mixing SI with Organic Chemistry classes ends in a good effect on pupils' behavior towards the materials and experience of a class. SI assisted pupils to comprehend the subject and content of the lesson better and prepared a situation in which pupils could argue to learn from each other and debate the subjects with other students and also SI coaches in a collaborative environment.

Our results show that SI enhances pupils' problem-solving capabilities and comprehension of Organic Chemistry content. Moreover, it lets pupils to strengthen the subjects learned through the lectures and prepares a situation in which students can solve the problems together, have a simplified learning environment and also have required time to contemplate debate and solve the problems. Pupils' ideas of SI were positive and they like the learning classes, personalized care, and collaborative learning teams.

According to the overall marks in Organic Chemistry class and the answers to a questionnaire, SI has been helpful with enhancing pupils' accomplishment, success and the educational experience. SI attendants earned a passing average of 81% in comparison with around 50% of non-SI pupils. SI attendance prepared a special and personalized learning experience for pupils which ended in an improved conceptual comprehension of the difficult Organic Chemistry content. It led to an improved accomplishment and success rate for SI pupils in comparison with non-SI attendants. SI affects attendants learning accomplishment along with their ideas and behavior towards the SI experience.

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