

Students Helping Students: Evaluating a Pilot Program of Peer Teaching for an Undergraduate Course in Human Anatomy

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The educational literature generally suggests that supplemental instruction (SI) is effective in improving academic performance in traditionally difficult courses. A pilot program of peer teaching based on the SI model was implemented for an undergraduate course in human anatomy. Students in the course were stratified into three groups based on the number of peer teaching sessions they attended: nonattendees (0 sessions), infrequently attended (1-3 sessions), and frequently attended (≥ 4 sessions). After controlling for academic preparedness [i.e., admission grade point average (AGPA)] using an analysis of covariance, the final grades of frequent attendees were significantly higher than those of nonattendees ($P = 0.025$) and infrequent attendees ($P = 0.015$). A multiple regression analysis was performed to estimate the relative independent contribution of several variables in predicting the final grade. The results suggest that frequent attendance ($\beta = 0.245$, $P = 0.007$) and AGPA ($\beta = 0.555$, $P < 0.001$) were significant positive predictors, while being a first-year student ($\beta = -0.217$, $P = 0.006$) was a significant negative predictor. Collectively, these results suggest that attending a certain number of sessions may be required to gain a noticeable benefit from the program, and that first-year students (particularly those with a lower level of academic preparedness) would likely stand to benefit from maximally using the program. End-of-semester surveys and reports indicate that the program had several additional benefits, both to the students taking the course and to the students who served as program leaders. *Anat Sci Educ* 9: 132–142. © 2015 The Authors. *Anatomical Sciences Education* published by Wiley Periodicals Inc. on behalf of the American Association of Anatomists. This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

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INTRODUCTION

Improving student learning and retention in traditionally difficult courses is a priority and challenge for any academic

unit. Among the methods that are used by institutions to address this issue, one that has received much attention in the educational literature is supplemental instruction (SI). For an overview of the SI model, see Blanc et al. (1983), Arendale (1994), Blanc and Martin (1994), Widmar (1994), and Hurley et al. (2006). By way of a brief summary, SI is a peer-facilitated academic support program that was pioneered in the 1970s at the University of Missouri-Kansas City as a means of reducing attrition in its health science professional schools. The program has since evolved to become a means of improving academic performance and retention in “high-risk courses” (i.e., $\geq 30\%$ of students fail or withdraw), and was recognized as an “Exemplary Educational Program” in 1981 by the U.S. Department of Education (Widmar, 1994).

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Rather than being offered broadly to an entire student population, as is the case with many student support programs, an SI program is attached directly to a course. Importantly, SI programs avoid a “remedial” label for participating students since high-risk courses are targeted, rather than high-risk students; attendance is voluntary and open to all students enrolled in the target course; and it is proactive rather than reactive (i.e., it starts in the first week of a semester rather than after academic difficulty is encountered). SI program delivery is via regularly-scheduled (e.g., weekly) cocurricular study sessions whose focus is to integrate the course content with the development of effective learning and study strategies (e.g., time management, vocabulary/terminology acquisition, note taking techniques, development of visual aids and other memory techniques, test preparation). The sessions are facilitated by undergraduate students (i.e., SI leaders) who have successfully completed the course, have good interpersonal and communication skills, and are able to foster a collaborative learning environment in which students engage in active learning and take responsibility for their own progress.

The effectiveness of an SI program is commonly assessed by comparing SI attendees and non-attendees on outcomes related to academic performance (Blanc et al., 1983; Hurley et al., 2006). Many studies have reported that SI attendees obtain significantly higher final course grades and/or have significantly higher retention rates compared to nonattendees in a wide range of subject areas and institutional settings: e.g., the natural sciences (Blanc et al., 1983; Ramirez, 1997; Peterfreund et al., 2007–2008); the social sciences and humanities (Blanc et al., 1983; Ramirez, 1997; Hodges et al., 2001); and mathematics and engineering (Hodges et al., 2001; Malm et al., 2011, 2012). Since selection bias is a potentially confounding issue due to the voluntary nature of SI session attendance, differences in performance outcomes between SI attendees and non-attendees may also reflect the contribution of other variables (e.g., academic preparedness, prior academic achievement, motivation). Many researchers have addressed this concern indirectly by comparing SI attendees and non-attendees on potentially confounding variables. The literature on SI effectiveness also includes examples whereby the effects of confounding variables have been directly controlled for through the use of an analysis of covariance (ANCOVA) and/or regression analysis: e.g., the natural sciences (Kochenour et al., 1997; Warren and Tonsetic, 1997; Congos, 1998; Gattis, 2002; Hensen and Shelley, 2003; Oja, 2012; Rath et al., 2012); the social sciences and humanities (Kochenour et al., 1997; Warren and Tonsetic, 1997; and mathematics and engineering (McCarthy et al., 1997; Fayowski and MacMillan, 2008). Overall, this body of evidence generally suggests that SI attendance has a significant independent effect on academic performance.

Despite its origins in the health sciences, there are only a handful of published studies in the peer-reviewed literature that describe SI programs associated with health science courses. A majority of these studies are related to courses delivered in a medical school setting. Bridgham and Scarborough (1992) compared grades (physiology, biochemistry, and pharmacology) obtained by SI attendees with predicted grades whose calculation was partly based on grades obtained by students in the two years preceding the implementation of the program. Likewise, Sawyer et al. (1996) compared grades (anatomy, microanatomy, physiology, biochemistry) obtained by SI attendees with the grades of students in the three years preceding the implementation of the program. The results of both of these studies suggested that their respective SI programs had a beneficial effect on academic performance. For-

ester et al. (2004) compared the grades obtained on an anatomy laboratory examination by SI attendees with the grades obtained by students in the preceding year; it should be noted that this study used four separate “SI programs”, none of which mirrors the traditional descriptions of SI in the literature. Finally, Hurley et al. (2003) and Kibble (2009) assessed the immediate short-term effect of their SI sessions on knowledge related to the session topic; however, neither of these studies assessed the effect of SI session attendance on academic performance in their respective courses (integrated study of disease, Hurley et al., 2003; physiology, Kibble, 2009).

Regarding SI programs associated with health science courses delivered outside a medical school setting, SI attendees obtained significantly higher final grades in an undergraduate human anatomy course (Hughes, 2011) and a chemistry course for nursing students (Van Lanen and Lockie, 1997). Additionally, Fjortoft et al. (1993) used multiple regression analysis to identify significant predictors for the final grade in a pharmacy course. The only significant predictor identified by their analysis was “academic ability” (calculated using a regression equation that incorporated the score on an admission test and preadmission science grade point average); age, gender, and SI attendance were not significant predictors in their regression model. Finally, Youdas et al. (2008) and Sole et al. (2012–2013) described the perceived benefits reported by physical therapy students who took part in peer teaching programs that mirror the traditional SI model; however, neither of these studies investigated the effect of their respective programs on academic performance.

Traditionally, SI is recommended for “high-risk courses” that have some or all of the following characteristics: a high proportion (e.g., $\geq 30\%$) of students who either fail or withdraw from the course, high student enrollment and/or a high proportion of first-year and second-year students, primarily lecture-style instruction with limited opportunity to ask questions, a large volume of weekly readings from challenging textbooks, and the course fulfills important pre-requisite requirements (Arendale, 1994; Kochenour et al., 1997). One subject area in the health sciences that commonly possesses many of these characteristics is human anatomy. However, as outlined in the preceding two paragraphs, there is a paucity of published literature related to SI programs offered to health science students enrolled in anatomy courses, especially for courses that are delivered outside a medical school setting. In particular, it is important to highlight that many of the described studies either did not assess the effect of SI attendance on academic performance in their respective courses (Hurley et al., 2003; Youdas et al., 2008; Kibble, 2009; Sole et al., 2012–2013) or involved analyses that compared the grades of SI attendees with grades obtained by students in the year(s) prior to the implementation of their respective SI programs (Bridgham and Scarborough, 1992; Sawyer et al., 1996; Forester et al., 2004). It is therefore difficult to draw any conclusions regarding the effect of these programs on academic performance. It is also important to emphasize that only four of the studies (Sawyer et al., 1996; Forester et al., 2004; Youdas et al., 2008; Hughes, 2011) involved programs offered to students enrolled in a human anatomy course, and of these only the studies by Youdas et al. (2008) and Hughes (2011) involved programs whose descriptions mirror the traditional SI model.

It should be noted that several additional peer teaching programs associated with human anatomy courses have been described in the peer-reviewed literature. For example, Johnson et al. (2012) and Evans and Cuffe (2009) described programs of peer teaching and near-peer teaching, respectively,

that involve peer (or near-peer) teachers in the delivery of mandatory curricular sessions (e.g., laboratory sessions). These programs are also quite distinct from the traditional SI model, which involves voluntary co-curricular study sessions organized and facilitated by the SI leaders. Additionally, Hendelman and Boss (1986), Krych et al. (2005), and Bentley and Hill (2009) described reciprocal peer teaching programs in which students enrolled in their anatomy courses alternated between the roles of teacher and learner. In traditional SI, students enrolled in the course do not take on the role of teacher during the SI sessions. Such distinctions suggest that peer teaching programs based on the traditional SI model would likely provide different learning opportunities, both for the students and SI leaders, than those that have been described for other types of peer teaching programs.

There are two additional crucial gaps in the SI-related literature. First, there has been little attention to the effect that increased attendance frequency may have on academic performance outcomes. A majority of the published studies have defined an SI attendee as a student who attended at least one SI session. However, as suggested by McCarthy et al. (1997), such a classification scheme discounts the possibility that attending more sessions results in a greater effect. Indeed, some studies have reported a significant weak positive correlation between final grade and the number of SI sessions attended (Kochenour et al., 1997; McCarthy et al., 1997; Oja, 2012), and that students who frequently attended SI sessions outperformed students who infrequently attended (Kochenour et al., 1997; Malm et al., 2011, 2012). None of these studies involved a health science course. The second gap is that only a few studies have systematically collected and analyzed the perceived benefits of an SI program from the students or SI leaders participating in the program. As suggested by McCarthy et al. (1997) and Congos and Schoeps (1999–2000), collecting such feedback, particularly qualitative feedback, is crucial to understanding the means by which SI programs have their effect and contribute to the learning process. A number of researchers have asked students to rate the perceived benefit of the sessions on their academic performance using Likert scales (Lundeberg, 1990; Fjortoft et al., 1993; Donelan and Kay, 1998; Youdas et al., 2008). However, only a few studies have systematically collected and analyzed qualitative data from students and SI leaders; of these, Youdas et al. (2008) is the only study to have done so for an anatomy course.

Therefore, the current study had the following primary objectives. For a pilot program of peer teaching that was based on the SI model and offered to students enrolled in an undergraduate course in human anatomy: (1) Investigate whether there is a difference in academic performance between students who attend peer teaching sessions (both frequently and infrequently) and those who do not attend; (2) Investigate the strength of association between peer teaching session attendance and academic performance; (3) Systematically collect, analyze, and report on the perceived benefits of students participating in the peer teaching program; (4) Systematically collect, analyze, and report on the perceived benefits of leaders participating in the peer teaching program.

METHODS

Human Anatomy Course

The human anatomy course (KIN 260) is delivered in the undergraduate curriculum of the Faculty of Kinesiology and

Health Studies (KHS) at the University of Regina (Regina, SK, Canada). The course is a core requirement for the Bachelor of Kinesiology and the Therapeutic Recreation major within the Bachelor of Sport and Recreation Studies. It has no prerequisite courses, and is itself a prerequisite for four courses delivered by the Faculty (Human Physiology I, Biomechanics, Motor Learning and Control, and Care and Prevention of Athletic Injuries). The course spreads over a single semester (13 weeks) and is comprehensive in covering all of the systems of the human body, with a focus on the skeletal, muscular, and nervous systems. At the time of the study, the lead investigator (P.A.B.) had been the course instructor for four years (2011–2014). In 2011 and 2012, ~25% of the students who enrolled either failed or withdrew from the course. The course is open to undergraduate students from across the university; however, majority of the students who enroll in the course each year are first-year and second-year KHS students. Course delivery is via traditional face-to-face lectures that primarily use PowerPoint presentations (27.5 contact hours), and laboratory sessions using anatomical models (10 contact hours). Course assessment is via two midterm examinations using multiple choice questions (each 15% of the final grade), two laboratory examinations using short-answer questions (each 10% of the final grade), and a final examination using multiple choice questions (30% of the final grade). In addition, students received credit for completing 10 weekly online assignments (10% of the final grade), eight written laboratory assignments (8% of the final grade), and the consent form (1%) and survey (1%) related to this study (see Ethical Considerations section below).

Peer Teaching Program

During the Winter 2013 semester, a pilot peer teaching program based on the SI model was initially offered to students enrolled in the human anatomy course. Ten one-hour peer teaching sessions were offered during the semester. To increase the availability of the program, the content for each session was delivered twice per week with two of the co-investigators (S.L.L., D.A.H.) leading their own sessions. Feedback was solicited from the students at the end of the course using an online survey. Students who attended the sessions indicated a high level of satisfaction with most aspects of the peer teaching program. When students who did not attend any of the sessions were asked their reason(s) for not attending, the most common response was that the session times clashed with their scheduled lectures and laboratories. The most common suggestion for program improvement provided by the students (both attendees and nonattendees) was to offer more sessions and/or offer them at different times during the week. Based on these encouraging results for the initial offering of the program, Faculty support was obtained to continue and expand the peer teaching program the following year.

In the Winter 2014 semester, nine one-hour peer teaching sessions were offered: the first session provided an introduction to the terminology used in the course, as well as general tips and strategies for success in the course; there were five sessions that contained activities and learning strategies related to body systems that are emphasized in the course (i.e., skeletal system, muscular system, nervous system, endocrine system, and cardiovascular system); the remaining three sessions involved a mock mid-term examination and two

mock laboratory examinations. Four weeks did not have a peer teaching session. Sessions were open to all students enrolled in the course, and attendance was voluntary. No attempt was made to target students based on academic performance. The sessions were led by five of the co-investigators (S.L.I., D.A.H., S.J.I., K.A.H., and S.M.P.), all of whom had previously achieved high final grades in the course (i.e., $\geq 80\%$). To maximize availability of the program, the content for each session was delivered several times each week with the program leaders leading their own sessions. In addition to facilitating the sessions, the program leaders attended all course lectures and met with the course instructor on a weekly basis to discuss their ideas related to session content and organization.

Data Collection

At the start of each peer teaching session, attendees signed an attendance sheet. At the end of the semester, these sheets were collected and used to calculate the number of sessions each student attended throughout the semester.

At the end of the semester, each student received a final grade (%), and their year of study, program of study, and admission grade point average (AGPA; %) were obtained from the University's central database. For year of study, students were categorized as first-year (i.e., ≤ 30 credit hours completed) or non-first-year. For program of study, students were categorized as KHS or non-KHS. AGPA was used as a measure of a student's academic preparedness. For high school admit students (i.e., students who were admitted directly from high school or who had completed < 24 credit hours of accredited post-secondary courses), the AGPA was calculated based on the grades from the final courses used for admission into the University. For transfer students (i.e., students who had completed ≥ 24 credit hours of accredited postsecondary courses), the AGPA was calculated based on grades from all completed postsecondary courses.

At the end of the semester, each student was asked to complete a survey that allowed for both quantitative (Likert scales) and qualitative (open-ended questions) data to be collected regarding their perceptions of the peer teaching program (see Supporting Information files). The survey questions were initially developed by the lead investigator (P.A.B.) and subsequently revised following consultation with three of the co-investigators (J.K.L.G., S.L.I., and D.A.H.). The first question asked the student if they attended any peer teaching sessions. Students who answered "yes" were then asked a series of questions primarily related to their satisfaction with various aspects of the program, perceived benefit of the program, and suggestions for program improvement. Students who answered "no" were asked a series of questions related to their reasons for not attending.

At the end of the semester, the program leaders were asked to reflect on their experience with the program (e.g., benefits, negative outcomes, suggestions for program improvement) and provide a short report (1-2 typed written pages) based on these reflections.

Data Analysis

All quantitative statistical analyses were performed by the lead investigator (P.A.B.) using IBM SPSS Statistics for Windows, Version 21.0 software (IBM Corp., Armonk, NY);

an alpha (α) level of 0.05 was used for all analyses. All qualitative analyses were performed by one of the co-investigators (K.L.S.) using NVivo for Mac software (QSR International Pty Ltd, Melbourne, Australia).

Group Demographics and Program Utilization

Students were stratified into three groups based on the number of peer teaching sessions they attended: non-attendees (0 sessions), infrequently attended (1–3 sessions), and frequently attended (≥ 4 sessions). To assess the types of students that used the peer teaching program, several analyses were performed. First, the proportion of first-year students and KHS students in the three groups were compared using separate chi-square tests. Additionally, the mean APGAs of the three groups were compared using a one-way analysis of variance (ANOVA); post-hoc analyses were performed using Bonferroni pairwise comparisons. Finally, the correlations between the year of study (1–5⁺) and the raw number of sessions attended (0–9), and between AGPA and the raw number of sessions attended (0–9), were assessed by calculating the Spearman rank correlation coefficient.

Association between Session Attendance and Academic Performance

To assess the association between peer teaching session attendance and final grade, several analyses were performed. First, the mean final grades of the three groups were compared using a one-way ANOVA and a one-way ANCOVA with AGPA as the covariate; all post-hoc analyses were performed using Bonferroni pairwise comparisons. Additionally, the correlations between the raw number of sessions attended (0–9) and the final grade, and between AGPA and the final grade, were assessed by calculating the Spearman rank correlation coefficient. Finally, a multiple regression analysis was performed to estimate the relative independent contribution of several variables in predicting the final grade (dependent variable). A forced entry method was used in which the following independent variables were simultaneously entered into the regression model: AGPA, frequent peer teaching attendance (≥ 4 sessions), infrequent peer teaching attendance (1–3 sessions), year of study (first-year vs. non-first-year), and program of study (KHS vs. non-KHS). For the two peer teaching attendance variables, indicator (dummy) variables were constructed indicating frequent (≥ 4 sessions) and infrequent (1–3 sessions) attendance, with the nonattendance group (0 sessions) serving as the comparison (omitted) group.

Perceptions of the Program (Students)

For those students who reported having attended at least one peer teaching session on the end-of-term survey, descriptive statistics were used to report their reason(s) for attending and level of satisfaction with the various aspects of the program. For those students who reported not having attended any peer teaching sessions, descriptive statistics were used to report their reason(s) for not attending.

Students who reported having attended at least one session were stratified into two categories based on the number of sessions they attended: infrequently attended (1–3 sessions) and frequently attended (≥ 4 sessions). The mean perceived

Table 1.

Comparison of Demographic Variables for the Students Who Attended Various Numbers of Sessions

Variables	Nonattendees (0 sessions)	Infrequently attended (1-3 sessions)	Frequently attended (≥ 4 sessions)	Group comparisons
First-year students ^a (%)	56.1	60.4	59.1	$\chi^2(2) = 0.179, P = 0.914$
KHS students ^a (%)	78.0	64.2	75.0	$\chi^2(2) = 2.541, P = 0.281$
AGPA ^b (mean ± SD)	78.8 (±7.5)	84.1 (±7.4)	82.8 (±8.8)	$F(2,125) = 5.062, P = 0.008$ NON vs. INF: $P = 0.007$ NON vs. FREQ: $P = 0.075$ INF vs. FREQ: $P = 1.00$

^aGroup comparisons performed using a chi-square test, $n = 138$.

^bGroup comparisons performed using a one-way ANOVA; Post-hoc analyses were performed using Bonferroni pairwise comparisons, $n = 128$.

AGPA: admission grade point average; KHS: Kinesiology and Health Studies; NON: nonattendees (0 sessions); INF: infrequently attended (1–3 sessions); FREQ: frequently attended (≥ 4 sessions).

benefit (i.e., how much their performance in the course was helped by the peer teaching sessions) of the students in the two categories was compared using an independent t test.

A content analysis of the responses to the open-ended questions on the survey was performed. The data was analyzed through a process of assigning codes, and identifying categories and themes. Coding was done through a three-step process that involved open, axial, and selective coding (Strauss and Corbin, 1990). While open coding was used, experiences surrounding positive aspects and suggested improvements were also specifically looked for since these were specific areas for which the students were asked to provide comment. To illustrate the process, an open code that was used was “more sample examinations.” This was placed in the “teaching methods” category, which was housed in the “improvements” theme.

Perceptions of the Program (Program Leaders)

A content analysis of the end-of-term reports submitted by the program leaders was performed. The data was analyzed through a process of assigning codes, and identifying categories and themes. Coding was done through a three-step process that involved open, axial, and selective coding (Strauss and Corbin, 1990). While open coding was used, experiences surrounding benefits, negative outcomes, and suggested improvements were specifically looked for since these were specific areas that the program leaders were asked to reflect upon. To illustrate the process, an open code that was used was “helping students achieve goals.” This was placed in the “interacting with students” category, which was housed in the “benefits” theme.

Ethical Considerations

The study was approved by the University of Regina Research Ethics Board. During the first lecture, one of the co-investigators (J.K.L.G.) described the nature of the study to the students enrolled in the course. It was described that each student would receive: (1) an e-mail request to complete

an online consent form regarding the use of their data for the study, and (2) an email request to complete the end-of-term online survey regarding their perceptions of the peer teaching program. The survey contained its own consent form regarding the use of the response data for the study. Students received 1% toward their final grade for completing the consent form and 1% towards their final grade for completing the survey; these grades were awarded to students who

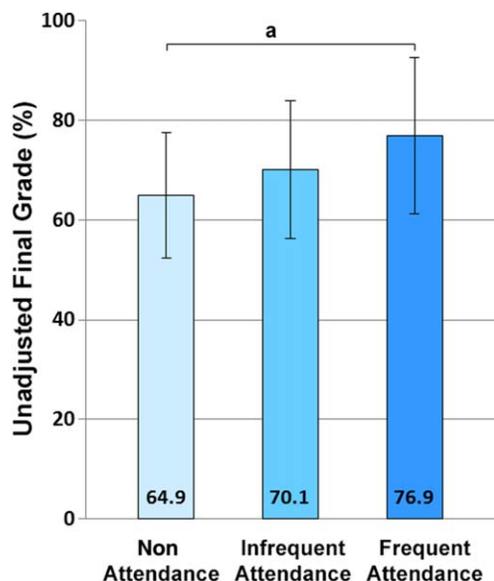


Figure 1.

Unadjusted final grades for the students who attended various numbers of sessions expressed in means ± SD (error bars). Group comparisons performed using a one-way analysis of variance (ANOVA) and post-hoc analyses were performed using Bonferroni pairwise comparisons; $n = 135$; $F(2,132) = 7.453, P = 0.001$; ^aNON vs. FREQ: $P = 0.001$; NON vs. INF: $P = 0.250$; INF vs. FREQ: $P = 0.062$; NON, nonattendance (0 sessions); INF: infrequent attendance (1–3 sessions); FREQ, frequent attendance (≥ 4 sessions).

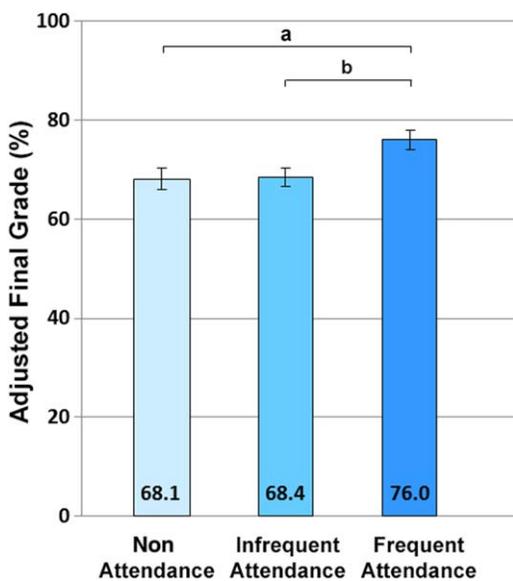


Figure 2.

Adjusted final grades for the students who attended various numbers of sessions expressed in means \pm SE (error bars). Group comparisons performed using a one-way ANCOVA with AGPA as the covariate. Post-hoc analyses were performed using Bonferroni pairwise comparisons; $n = 125$; $F(2,121) = 5.168$, $P = 0.007$; ^aNON vs. FREQ: $P = 0.025$; ^bINF vs. FREQ: $P = 0.015$; NON vs. INF: $P = 1.000$; NON, nonattendance (0 sessions); INF: infrequent attendance (1–3 sessions); FREQ: frequent attendance (≥ 4 sessions).

provided consent to use their data as well as to students who did not provide consent. Providing credit for the completion of these items was a means to encourage their completion, rather than a means to encourage students to provide consent, thereby minimizing the potential for bias to be introduced to the study. To further minimize undue influence and coercion regarding involvement with the study, the lead investigator (P.A.B.) was not present in the lecture hall when the study was described to the students. In addition, although

the lead investigator was informed which students had completed the consent form and survey at the end of the course to award the grades for completing these items, information regarding whether a student provided consent was withheld until after all of the final grades had been submitted to the Faculty administration. All students were encouraged to attend the peer teaching sessions, regardless of whether they provided consent to participate in the study.

RESULTS

Student Participants

In the Winter 2014 semester, 170 students enrolled in the human anatomy course. Regarding the consent form, 81.2% (138/170) of the students completed the form and provided consent to have data used in the study (mean age at the start of the semester: 20.5 (SD ± 3.9) years; 67.4% female, 32.6% male). Three of these students withdrew from the course and did not receive a final grade. These individuals were not included in any of the analyses related to the final grades. Additionally, an AGPA was not available for 10 students (e.g., mature admit students, casual students). These individuals were not included in any of the analyses related to AGPA.

Group Demographics and Program Utilization

A mean of 47.4 (SD ± 10.2) students attended the peer teaching sessions each week, with each student attending a mean of 2.75 (SD ± 2.79) sessions over the course of the semester. Forty-one (29.7%) students were classified as nonattendees, 53 (38.4%) students were classified as infrequent attendees, and 44 (31.9%) students were classified as frequent attendees. A summary of the group demographics is presented in Table 1. There were no significant differences between the three groups in the proportion of first-year students or proportion of KHS students. However, when the AGPAs of the three groups were compared (ANOVA), a significant main effect was found; pairwise comparisons revealed that the AGPAs of the nonattendees were significantly lower than the

Table 2.

Summary Findings for the Multiple Regression Analysis Performed to Estimate the Relative Independent Contribution of Several Variables in Predicting the Final Course Grade (Dependent Variable)

Variables	B	SE B	β	t	P-value
AGPA	1.045	0.143	0.555	7.300	<0.001
Frequent attendance	7.991	2.889	0.245	2.765	0.007
Infrequent attendance	0.717	2.803	0.023	0.256	0.798
Year of study (first-year)	-6.736	2.382	-0.217	-2.828	0.006
Program of study (KHS)	2.775	2.650	0.081	1.047	0.297

Note: $R^2 = 0.387$; $F(5,119) = 15.047$; $P < 0.001$.

The regression model significantly predicted 38.7% of the variance in the final grade students with a higher AGPA and students who frequently attended the sessions were predicted to have a significantly higher final grade; first-year students were predicted to have a significantly lower final grade; program of study (KHS) and infrequent attendance were not significant predictors of the final grade; frequent attendance = attended ≥ 4 sessions; infrequent attendance = attended 1–3 sessions; AGPA: admission grade point average; KHS: Kinesiology and Health Studies.



Figure 3.

Attendee satisfaction with specific aspects of the program expressed in means \pm SD (error bars). Scores were provided using a seven-point Likert scale where 1 = not satisfied at all and 7 = extremely satisfied.

students who infrequently attended the sessions and marginally lower than the students who frequently attended the sessions. In addition, there was a significant weak positive correlation between AGPA and the number of sessions attended ($r_s = 0.197$, $P = 0.026$); however, there was no significant correlation between year of study and the number of sessions attended ($r_s = -0.022$, $P = 0.802$).

Session Attendance and Academic Performance

A summary of the between-group comparisons in final grades is presented in Figures 1 and 2. The students who frequently attended the peer teaching sessions had the highest mean final grade (76.9%), while the nonattendees had the lowest mean final grade (64.9%). When the final grades of the three groups were compared (ANOVA), a significant main effect was found; pairwise comparisons revealed that the final grades of the students who frequently attended the sessions were significantly higher than nonattendees and marginally higher than the students who infrequently attended the sessions (Fig. 1). When the final grades of the three groups were compared after controlling for effect of AGPA (ANCOVA), a significant main effect was found; pairwise comparisons revealed that the final grades of the students who frequently attended the sessions were significantly higher than nonattendees and the students who infrequently attended the sessions (Fig. 2).

There were significant moderate positive correlations between the number of sessions attended and the final grade ($r_s = 0.313$, $P < 0.001$), as well as between AGPA and the final grade ($r_s = 0.545$, $P < 0.001$). A summary of the multiple regression analysis is presented in Table 2. The regression model significantly predicted 38.7% of the variance in the final grade. Both AGPA and frequent peer teaching attendance were significant positive predictors of the final grade,

while year of study (first-year) was a significant negative predictor. The value of its regression coefficient indicates that frequent peer teaching attendance was associated with an 8% increase in the final grade, on average, if the effects of the other variables in the regression model are held constant. Infrequent peer teaching attendance and program of study (KHS) were not significant predictors of the final grade.

Perceptions of the Program (Students)

Regarding the end-of-term survey, 82.4% (140/170) of the students completed the survey and provided consent to have their response data used in the study. Of these, 74.3% reported having attended ≥ 1 session. When attendees were asked the reason(s) for attending the peer teaching sessions, the most common response (95.2%) was that they thought it would help their performance in the course. When the 25.7% of survey respondents who reported not having attended any sessions were asked their reason(s) for not attending, the most common response (63.9%) was that the session times clashed with their scheduled lectures and laboratories. When asked the likelihood that they would have attended the sessions if they had been scheduled at different times (Likert scale: 1 = not likely, 7 = very likely), the mean score provided was 4.8 (SD ± 2.1); 61.1% provided a score of 5-7.

The reliability of the items that comprised Question 4 (program satisfaction) and Question 5 (session satisfaction) was assessed by calculating Cronbach's α for each question. Question 4 (3 items) had acceptable reliability (Cronbach's $\alpha = 0.639$), while Question 5 (8 items) had good reliability (Cronbach's $\alpha = 0.775$). Attendees generally reported a high level of satisfaction with various aspects of the peer teaching program as well as the individual sessions. The aspects of the peer teaching program that received mean satisfaction ratings ≥ 5 are presented in Figure 3. When attendees were asked to rate how much their performance in the course was helped by the peer teaching sessions (Likert scale: 1 = did not help at all, 7 = helped significantly), the mean score provided was 4.7 (SD ± 1.3); 64.8% provided a score of 5-7. When attendees were stratified based on the number of sessions they reported having attended, the students who frequently attended the sessions perceived a marginally higher benefit from the peer teaching sessions compared with the students who infrequently attended the sessions [4.9 (SD ± 1.1) vs. 4.4 (SD ± 1.4); $P = 0.053$].

The content analysis of the responses to the open-ended survey questions revealed that attendees recognized numerous additional benefits to the program. A large number of students (58) noted that they better understood the material and felt more prepared for examinations as a result of attending the sessions. They often acknowledged that the increase in preparation led to a decrease in course-related anxiety and stress. Another described benefit was the environment, which was also mentioned as a reason for attending. Due to the small-group nature of the sessions, the students commented that it was a comfortable setting in which to ask questions. They also spoke to the inclusive nature of the sessions (i.e., they felt welcomed and were not embarrassed about not knowing the material). Additionally, they enjoyed the variety of teaching methods that were used, which allowed them to engage with the material in a different way from the lectures. Lastly, students appreciated the experience and knowledge of

the instructors and noted that, in addition to being able to answer their questions, the instructors offered great tips and advice based on their previous experiences with the course. For example, the instructors shared the techniques that they used to learn the material and encouraged students to focus on areas of particular importance.

Perceptions of the Program (Program Leaders)

The content analysis of the reports submitted by the program leaders revealed that they also experienced several benefits from participating in the program. They all mentioned the development of professional skills (e.g., time management, teamwork) from leading the sessions. They also spoke to the enjoyment of working with the students and being able to share their tips and advice for the course. The two individuals who served as the peer teaching program leaders in 2013 found that having more sessions and leaders in 2014 was beneficial. With more sessions, they found the groups of students to be smaller, allowing for more one on one interaction. With more leaders, they felt that there was more collective knowledge to be shared and more flexibility in the scheduling, which allowed them more time to work on their other courses. Lastly, two of the leaders noted that leading the sessions allowed them to stay up to date with the material from the course, which proved to be beneficial for the courses they were currently taking and their future career goals.

DISCUSSION

There is a paucity of published peer-reviewed literature regarding the effectiveness of SI programs in improving academic performance in health science courses. A pilot program of peer teaching based on the SI model was implemented for an undergraduate course in human anatomy. The results of the current study provide preliminary evidence that this program was associated with an improvement in academic performance, as well as additional benefits for both the student attendees and the program leaders. After controlling for academic preparedness (i.e., AGPA), the final grades of frequent attendees were significantly higher than those of non-attendees and infrequent attendees (Fig. 2). The regression model suggests that both frequent attendance and AGPA were positive predictors of the final grade, whereas being a first-year student was a negative predictor; infrequent attendance was not a significant predictor of the final grade (Table 2). Collectively, these results strongly suggest that frequent attendance (but not infrequent attendance) was independently associated with a significant improvement in academic performance in the course.

There are several published reports that have included measures of academic preparedness and/or prior academic achievement in their analyses on the effects of SI on academic performance; however, only one of these relates to a health science course (Fjortoft et al., 1993). Using such measures as a covariate (ANCOVA), studies have reported significantly higher final grades for SI attendees after controlling for the effects of high school grades and aptitude test score (Congos and Schoeps, 1993; Warren and Tonsetic, 1997; Hensen and Shelley, 2003), predicted grade point average (Congos and Schoeps, 1993; Kochenour et al., 1997; Congos, 1998; Gattis, 2002), and prior post-secondary grade point average (Fayowski and MacMillan, 2008). It should be noted that

four of these studies defined an “attendee” as a student who attended ≥ 1 session (Kochenour et al., 1997; Warren and Tonsetic, 1997; Gattis, 2002; Hensen and Shelley, 2003), while three defined an “attendee” as a student who attended ≥ 5 sessions (Congos and Schoeps, 1993; Congos, 1998; Fayowski and MacMillan, 2008). Additionally, several authors have attempted to assess the relative independent contribution of academic preparedness and/or prior academic achievement in predicting academic performance (multiple regression). Although Fjortoft et al. (1993) reported that SI attendance was not a significant predictor of academic performance, several authors have found SI attendance to be a positive predictor (Fayowski and MacMillan, 2008; Oja, 2012; Rath et al., 2012). Studies have also found that aptitude test scores, high school grades, and prior post-secondary grades were positive predictors of academic performance (Fjortoft et al., 1993; Fayowski and MacMillan, 2008; Oja, 2012; Rath et al., 2012). However, McCarthy et al. (1997) have suggested that since typical measures of academic preparedness (e.g., AGPA) may not be reliable predictors of academic success at university, alternative measures of a student’s “academic ability in the university environment” (e.g., aggregate grade of all common courses completed by the students in the course) should be used in analyses of SI effectiveness. The regression model reported by McCarthy et al. (1997) indicated that such a measure was a positive predictor of academic performance, whereas SI attendance was not a significant predictor. Such a measure of “academic ability at university” was not available for the current study since the Faculty of Kinesiology and Health Studies at the University of Regina does not have a fixed curriculum and the human anatomy course is open to students from across the University.

Many studies have compared SI attendees and non-attendees at baseline for measures of academic preparedness and/or prior academic achievement. Although some have reported significant differences either in favor of their SI attendees (Warren and Tonsetic, 1997; Malm et al., 2012) or non-attendees (Congos and Schoeps, 1993; Hensen and Shelley, 2003; Peterfreund et al., 2007–2008; Rath et al., 2012), many have reported no significant difference in such measures between their SI attendees and non-attendees (Blanc et al., 1983; Congos and Schoeps, 1993; McCarthy et al., 1997; Ramirez, 1997; Van Lanen and Lockie, 1997; Congos, 1998; Hodges et al., 2001; Peterfreund et al., 2007–2008; Terrior and Daoust, 2011–2012). In this study, the mean AGPA of the non-attendees was significantly lower than the students who infrequently attended the sessions and marginally lower than the students who frequently attended the sessions (Table 1). This finding has two implications regarding the interpretation and application of the results of the current study. The first implication relates to the assumption for an ANCOVA that the covariate and treatment effects are independent (Miller and Chapman, 2001; Field, 2009). Since there was a significant between-group difference for the covariate and group membership was determined non-randomly, this assumption may have been violated. However, it should be noted that most of the SI-related studies that performed an ANCOVA also used nonrandom group assignment and either reported a significant between-group difference for the covariate (Congos and Schoeps, 1993; Warren and Tonsetic, 1997; Hensen and Shelley, 2003) or did not report statistical analyses of the between-group difference for the covariate (Kochenour et al., 1997; Gattis, 2002; Fayowski and

MacMillan, 2008). Therefore, the results of the ANCOVA (Fig. 2), as well as those reported in these other papers, should be interpreted with caution. The second implication relates to program utilization. Although the spirit of SI is that no attempt is made to specifically target students based on actual or expected academic performance, it is arguably desirable that the program be maximally used by those students who are predicted to perform poorly. The regression model suggests that AGPA is a positive predictor, and being a first-year student is a negative predictor, of the final grade (Table 2). This is not surprising since it is to be expected that students with a higher degree of academic preparedness (AGPA) and more experience in a university setting (non-first-year students) would be predicted to achieve higher final grades. Importantly, the findings of this study suggest that first-year students, particularly those with a lower AGPA, would stand to benefit more from maximally using the program. However, this did not appear to transpire in this study. The students who frequently attended and infrequently attended the sessions had a higher mean AGPA than nonattendees (Table 1), and there was a weak positive correlation between AGPA and the number of sessions attended. Conversely, the proportions of first-year students in the three groups were comparable (Table 1), and there was no significant correlation between year of study and the number of sessions attended. It should be highlighted, though, that 71.6% of the first-year students in the course attended at least one session, with 44.8% of these students attending ≥ 4 sessions.

Although a majority of the published studies related to SI have defined an attendee as a student who attended at least one session, some studies have categorized attendees into subgroups based on a specific number of sessions attended. However, only a handful of these studies have attempted to control for potentially confounding variables in their analyses. The results of Kochenour et al. (1997) demonstrated that students with infrequent (1–2 sessions) and frequent (≥ 3 sessions) attendance had significantly higher final grades compared with nonattendees after controlling for the effect of predicted grade point average (ANCOVA). Similarly, Gattis (2002) reported a significant between-group difference in final grades after controlling for the effect of predicted grade point average (ANCOVA), with a trend of frequent attendees (≥ 4 sessions) having the highest final grades and nonattendees having the lowest final grades. Unfortunately, this paper did not report the statistics for any post-hoc pairwise comparisons. Finally, a regression model reported by Fjortoft et al. (1993) suggested that neither moderate (3–10 sessions) nor high (≥ 11 sessions) SI attendance were a significant predictor of the final grade. The results of the ANCOVA and regression analysis contradict these previous reports. Both analyses suggest that while frequent attendance (≥ 4 sessions) was associated with an improvement in academic performance, infrequent attendance (1–3 sessions) was not (Fig. 2 and Table 2). It has been suggested that students may need to attend a minimum of 5 or 6 sessions to benefit from an SI program (McCarthy et al., 1997; Van Lanen and Lockie, 1997; Congos, 1998; Fayowski and MacMillan, 2008). However, none of these articles presented data comparing the academic performance of frequent and infrequent attendees to support this contention. The results of this study seem to support the notion that attending a certain number of sessions is required to gain a noticeable benefit from these types of programs. The specific threshold number of required sessions is likely to vary from course to course.

In addition to the potential effect on their final grades, students in the current study also described several additional benefits to participating in the program. Many of these mirror benefits that have been expressed by students taking part in SI programs associated with a range of courses: e.g., being exposed to a variety of teaching methods and approaches to learning the material (Lundeberg, 1990; Donelan and Kay, 1998; Youdas et al., 2008); gaining a better understanding of the material and being more prepared for examinations (Lundeberg, 1990; Price and Rust, 1995; Warren and Tonsetic, 1997; Donelan and Kay, 1998; Youdas et al., 2008; Sole et al., 2012); and having the opportunity to take part in sessions that were comfortable and inclusive (Lundeberg, 1990; Sole et al., 2012–2013). Several authors have also suggested that SI attendance may improve affective variables (e.g., self-efficacy, self-esteem) and help students bond with each other and their institution, thereby potentially having an impact on long-term retention and persistence in postsecondary education (Visor et al., 1992; Commander et al., 1996; Ogden et al., 2003; Terrion and Daoust, 2011–2012).

Regarding the nonattendees in the current study, the most common stated reason for not attending was that the session times clashed with their scheduled lectures and laboratories. This also reflects what has been reported previously (Lockie and Van Lanen, 1994; Van Lanen and Lockie, 1997; Donelan and Kay, 1998; Hughes, 2011). Since SI programs are often offered for courses with large enrolments and attendance is voluntary (i.e., students do not register for a specific session time), it is usually very difficult to coordinate session times that would meet the needs of every student in a course. Having SI program coordinators work closely with academic planning personnel at their respective institutions when planning SI session schedules would be one step in potentially alleviating this issue.

The program leaders in this study also expressed several benefits to participating in the program, which also tend to echo those expressed by other SI leaders from previous reports: e.g., improved content knowledge (Congos and Stout, 2003; Hurley et al., 2003; Lockie and Van Lanen, 2008; Youdas et al., 2008); development of interpersonal, professional, and leadership skills (Donelan and Kay, 1998; Congos and Stout, 2003; Zaritsky and Toce, 2006; Lockie and Van Lanen, 2008; Youdas et al., 2008); a sense of enjoyment in providing assistance to the students (Lockie and Van Lanen, 2008); and helping to focus their future career goals (Zaritsky and Toce, 2006). Ergo, the benefits of an SI program go well beyond simply serving as a method to improve academic performance in traditionally difficult courses. They also provide a unique and valuable opportunity for program leaders to develop personal and professional skills that would be of great benefit to them upon graduation.

Limitations

This study has several additional limitations that are worth considering. First, the results of this pilot study may not be replicable or generalizable to other institutions offering human anatomy courses as part of a medical or undergraduate health science curriculum. Second, the study only investigated the association between peer teaching session attendance and the performance in a single course, and did not assess the potential effect that the program may have on academic performance in other courses or long-term student

retention. Third, the AGPA calculations used in this study were based on the grades used for admission into the University (high school admit students; $n = 120$) or from completed post-secondary courses (transfer students; $n = 8$). Although it would have been preferable to use a common measure of academic preparedness for all of the participants, admission grades were not universally available. However, since post-secondary grades were used to calculate AGPA for a relatively small proportion of the participants, it is unlikely that this introduced any appreciable bias in this study. Fourth, the relatively small sample sizes (i.e., number of responses) for some of the items in Questions 4 and 5 of the end-of-term survey may limit the interpretability of the diagnostic statistical analyses (i.e., Cronbach's α) that relate to these questions. Finally, the regression model only accounted for 38.7% of the variance in the final grade, which is not surprising since many factors not accounted for in this study would also be expected to contribute to a student's academic performance: e.g., motivation, self-efficacy, extracurricular time commitments (e.g., family, work, athletics). Hodges et al. (2001) and Terrion and Daoust (2011–2012) both used an Academic Motivation Scale to estimate the motivation of their students. Price et al. (2012) used the Self-Efficacy for Learning Form (SELF) to estimate the self-efficacy of their students. However, neither of these studies controlled for the effect of these variables in their analyses on the effect of SI attendance on academic performance. In fact, there currently do not appear to be any published studies that have used direct measures of motivation or self-efficacy as covariates (ANCOVA) or included them as independent variables in regression analyses. Doing so would help provide further insight into the relative contribution of a student's motivation and self-efficacy, alongside their academic preparedness and SI attendance.

CONCLUSION

The peer teaching program that has been offered in conjunction with an undergraduate human anatomy course over the past two years has demonstrated substantial benefits, both to the students taking the course and to the students who have served as program leaders. Interestingly, the analyses indicate that attending a certain number of sessions may be required to gain a noticeable benefit from this program. Additionally, the results suggest that first-year students, particularly those with a lower level of academic preparedness, would stand to benefit from maximally using the program. Programs such as the one used in this study would seem to be a potentially promising tool in the delivery of traditionally difficult health science courses.

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