Structured Self-Assessment Exercises as a Substitute for Small-Group Tutorial Teaching in Diagnostic Imaging
Student Preferences and Effects on Examination Performance

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Research into chiropractic and medical education supports the concept of teaching in a problem-solving approach, simulating the realities of clinical practice. Along with this approach, small-group tutorials have more commonly become the method of delivery of course material, focusing on the learner rather than the teacher. However, offering frequent small-group tutorial sessions is very labor intensive for faculty. The purpose of this study was to determine whether or not structured self-assessment exercises could substitute for some small-group tutorial time without jeopardizing the quality of the students' education. At the end of the 1999–2000 academic year, a short questionnaire was administered to all 4th-year students to assess their attitudes and opinions about the value of each of the teaching/learning approaches utilized in radiology using a 5-point Likert scale. Final examination marks were compared to the previous cohort of students to determine changes in performance/radiological ability. The examination marks from the 4th-year cohort were compared to their own radiological examination marks from the previous year. The results indicate that students strongly prefer the small-group face-to-face tutorials with the faculty members but rated the self-assessment exercises as ``above average'' in usefulness. The interactive lecture was also rated as ``very useful.'' There was no meaningful or significant change in the final examination performances between the current 4th-year cohort and the previous group of students. For the first time in 10 years, no student failed the final film reading examination. It was concluded that the structured self-assessment exercises can serve as a very valuable learning tool and significantly reduce tutor contact time in an overburdened time-table but do not have a negative impact on students' diagnostic abilities. A combination of small-group tutorials and structured self-assessment exercises is the preferred approach, balancing the wishes of the students with the needs of the faculty as well as providing a varied educational learning experience. (The Journal of Chiropractic Education 15(2): 61–68, 2001)

Key words: assessment, diagnostic imaging, learning, radiology, teaching

INTRODUCTION

In many respects, educational processes within both chiropractic and medical education resemble vocational training. Because of the nature of the jobs that health care professionals are required to perform and the implications that their abilities have to human health and well-being, teaching and assessing approaches, along with the learning environment, must reflect these needs. Current knowledge dictates that clinical teaching must be presented in an integrated, problem-solving approach, simulating whenever possible the realities of clinical practice (1,2). Such an approach encourages deeper levels of understanding and promotes life-long learning (1,3,4).

To facilitate desirable learning habits, teaching and learning in the health care professions has changed in recent years, becoming focused on the "learner" and "learning" rather than on the "teacher" and "teaching" (5). Terms have arisen such as "self-directed learning" and "student-centered learning" which are bantered about like mantras in the educational environment, and are seen as

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important tools to facilitate problem-solving abilities and more desirable attitudes towards continuing professional education and development. However, many students initially experience frustration with self-directed learning as they perceive that it lacks direction (3). Paul et al. (6) reported that medical students preferred teacher-structured learning experiences dealing with concrete and applied tasks rather than abstract concepts. Furthermore, most students preferred organization within the curriculum and a close relationship with the teacher. While, on the surface, these student attitudes may appear to be the antithesis of the goals of self-directed learning in a problem-based approach, they are nevertheless valid and must be addressed when learning goals and exercises are created. Factors associated with an optimal learning environment include a relaxed teaching atmosphere, an enthusiastic teacher, a teacher who is knowledgeable in the subject matter, and one who does adequate preparation and is organized (7–9). All of these abilities can be incorporated into the problem-based setting and into creating effective self-directed learning experiences.

Perhaps a better approach, at least in the earlier years of clinical education, can be described as "directed learning." This method takes the best from the "self-directed" approach and the best from the "teacher-centered" approach creating *structured* learning tasks which can cover core materials, explore in-depth concepts, require active participation from the student, and use a problem-solving, clinically real approach while still allowing the student flexibility and the opportunity to acquire time management skills. This idea has already been effectively utilized and reported on in the medical education literature, being called "structured packs for independent learning" (3,4). Many computer-assisted learning programs are excellent examples of this (10). An additional benefit of these structured learning tools is the reduction of faculty contact time (4) which, for overburdened tutors, adds flexibility to managing their other professional commitments (3).

The issue of reducing faculty contact time is a prime concern at the Anglo-European College of Chiropractic (AECC) where the chiropractic faculty members have on average 32 scheduled hours per week, excluding meetings, research interests, planning and assessment tasks, and other professional demands. During the 1999–2000 academic year, the faculty members of the AECC were encouraged to be innovative in changing their teaching approaches and/or to rationalize course content to attempt to reduce this high teaching burden without negatively impacting on the course or learning experiences of the students. Rising to this challenge, the approach to teaching in Diagnostic Imaging was changed for the 3rd- and 4th-year students from small-group tutorials (approximately 20 students per group) given every week (in addition to the weekly interactive lecture), to small-group tutorials given only every other week, alternating with self-assessment exercises placed in the radiology learning laboratory covering the assigned new topics as well as previously covered material. Thus the number of hours of faculty contact with the students was approximately cut in half. The self-assessment exercises were all film assessment, structured exercises presented in a problem-based format including clinical information, the requirement to correlate the clinical information with imaging findings, management, laboratory, and follow-up questions. Each self-assessment exercise consisted of between 8 and 10 imaging cases and required short answers. A very detailed answer scheme was provided at the end of the self-assessment which often included in-depth discussion of clinical/chiropractic related topics illustrated by the case. The students had 1 week in which to complete each self-assessment, but they could go into the laboratory at any time and spend as much or as little time on each case as needed. Furthermore, students could determine whether or not they did all of these exercises, some of them, or none at all. It was their choice, and time management was completely left to them. There were 14 different self-assessment exercises provided during the 1999–2000 academic year for the 3rd-year students and another set of 14 self-assessment exercises targeting the 4th-year students (28 exercises in total).

Obviously the creation of such self-assessment exercises was very labor intensive in the short term, but as these cases can be used in subsequent years, the actual savings in tutor time occurs later. Initially, approximately 10 hours per week of faculty contact time was saved in the 1st year. Additionally, in the future these cases can be put onto the student intranet and used on computer by the students at their leisure for review, adding further flexibility. However, the most important issue is the impact, either positive or negative, that these self-assessment exercises have on student learning. If the students' film reading abilities and examination performances

deteriorate, then the time savings may not be cost-effective. The most important goal of any clinical faculty member is to ensure the safe and competent practice of the student, thus protecting their future patients. This study was undertaken to investigate the effect that these self-assessment exercises had on student performance, as well as to investigate the perceived usefulness of these exercises by the students.

METHODS

A short questionnaire was designed containing eight items. The first three questions asked the students to rate the usefulness to them of each of the three methods used to present radiology material. These included the radiology lectures, the small-group tutorials, and the self-assessment exercises. A 5-point Likert scale was used with the options ranging from 1, which represented "not at all useful," to 5, representing "very useful." The students were then asked to rank these same three teaching methods as to their first, second and third choice in terms of their learning preference. The next item required each student to select the single teaching/learning method (in addition to their weekly lecture) which they preferred out of the following three choices: small-group sessions weekly; self-assessment exercises weekly; or a combination of alternating small-group sessions and self-assessment exercises.

Because the introduction of the self-assessment exercises required student motivation and time management in order to complete these tasks, a question was included asking how often the student completed these exercises. Five options were given ranging from "Never" to "Always." Another item asked the students to compare the amount of study time devoted to radiology during the current academic year as compared to the previous year. This was done to determine whether or not the self-assessment exercises impacted on the quantity of their study time. Three options were given: more time than in the previous year; less time than in the previous year; or the same amount of time as in the previous year. Yet another questionnaire item asked each student to indicate within a percentage range where their radiology in-class test marks fell for the current academic year. This was done to attempt to correlate test performance with the frequency in which the self-assessment exercises were completed. The end of the questionnaire included a section allowing the students to make comments on their experiences using the self-assessment exercises and comparing this to the small-group tutorial sessions.

The questionnaire was given to several colleagues prior to use to assess its face and content validity. Once face and content validity were assured, 84% of the 4th-year students completed the questionnaire at the end of the 1999–2000 academic year. The students were assured that all responses were completely anonymous. The reason that this particular cohort of students was chosen is because this group had the experience of having weekly small-group radiology tutorials during their 3rd year but biweekly small-group tutorials alternating with the self-assessment exercises during their 4th year. Thus they were deemed able to make comparisons between the two approaches. Finally, the year-end radiology examination marks for the cohort were compared to their radiology examination marks from the previous year to note any significant deterioration or improvement.

The mean score from the 5-point Likert scale was determined for each of the three questions concerning the overall usefulness of the various methods of presenting diagnostic imaging material (i.e., lecture, small-group tutorial, and self-assessment exercise). The percentage of students who found the lectures, the small-group tutorials, or self-assessment exercises most useful was calculated. Percentages were also calculated to determine student choice in the format of delivery when comparing self-assessment exercises only, small-group tutorials only, or a combination of the two. The frequency of completing the self-assessment exercises was also determined using percentages. To compare test performance among the five different groups according to frequency of completing the self-assessment exercises, the Kruskal-Wallis (nonparametric ANOVA) was used as the statistical test of choice.

In order to compare overall examination performances over time and with previous groups, the final diagnostic imaging examination scores were obtained for the current 4th-year students and compared to the performance of the previous cohort of 4th-year students using the Mann Whitney-U test (the nonparametric t-test). Additionally, the current 4th-year final examination scores were compared to the same cohort's diagnostic imaging final examination performance from their previous year (3rd-year) using Wilcoxon (nonparametric *t*-test equivalent).

Table 1. Ranking of the Three Different Methods of Presenting Diagnostic Imaging Material

	1st choice	2nd choice	3rd choice
Small-group tutorial	68%	30%	1%
Lecture	28%	56%	16%
Self-assessment exercises	8%	13%	68%

Statistically significant differences were determined to be $p < .05$. These final examinations are comprehensive over all previous radiological material and consist of 15 film reading cases containing clinical information and are completed in 2 hours. Although the cases vary from year to year, the content is very similar. The Mann Whitney-U test was chosen instead of the Student *t*-test, as the data were not normally distributed, using a criterion-referenced marking scheme.

RESULTS

Based on the 5-point Likert scale where 1 = "not at all useful" and 5 = "very useful," the mean value for the students rating of the diagnostic imaging lecture was 4.6. The mean score for usefulness of the small-group tutorials was 4.7 and for the self-assessment exercises 3.6 (Fig. 1). Similar results were obtained for the ranking of these three different methods of teaching/learning diagnostic imaging with 28% of students ranking the lecture as the most useful method, 56% as the second most useful method, and 16% of students ranking it as least useful. For the small-group tutorials, 68% of students ranked this as the most useful teaching/learning method, with 30% rating it second and only 1% as least useful. Only 8% of the students ranked the self-assessment exercises as most useful, 13% as second, and the majority (68%) as the least useful teaching/learning method (see Table 1).

When faced with selecting one option for the weekly practical sessions, the results were as follows: 52% preferred weekly small-group tutorial sessions only; 44% chose a combination of half small-group tutorials and half self-assessment exercises, while only 4% preferred strictly self-assessment exercises every week (Fig. 2).

Thirty-six percent of the students stated that they completed the self-assessment exercises "always," 37% "usually" completed them, 25% did them "half of the time," 2% admitted that they "rarely" completed them, and none of the students acknowledged "never" doing any of these (Fig. 3). When comparing in-class test scores with the frequency of completing the self-assessment exercises, there was a trend for those students who completed these learning tools more often to obtain higher test scores, but this did not achieve statistical significance ($p = .43$).

Comparing the current cohorts' comprehensive film reading examination results to the previous

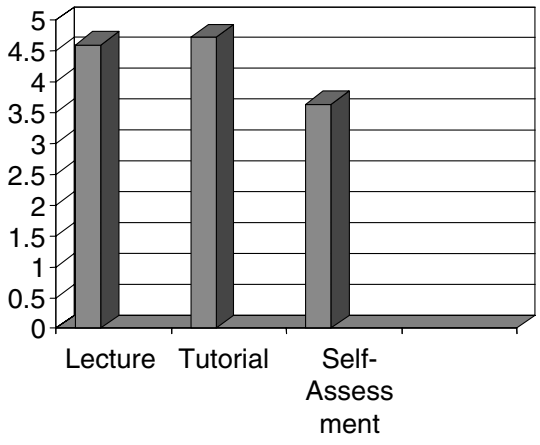

Figure 1. Mean rating of the usefulness of the three methods of presenting diagnostic imaging material (1 = not at all useful; 5 = very useful).

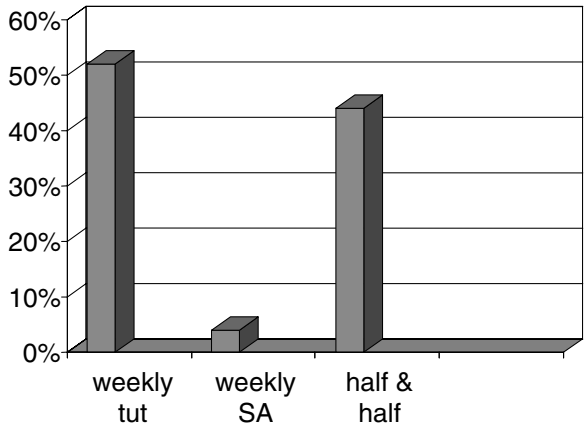

Figure 2. Choice of most favored practical sessions.

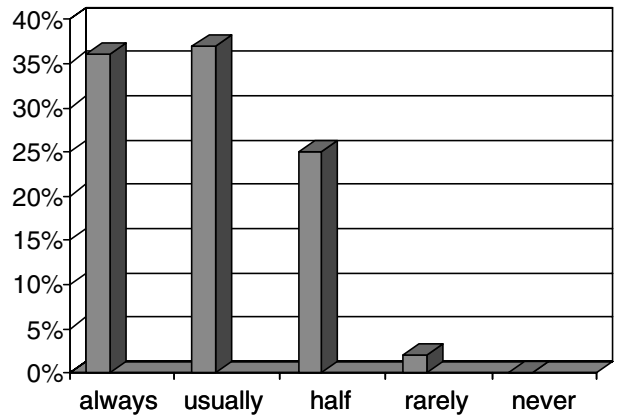

Figure 3. Frequency of students completing the self-assessment exercises.

4th-year performance showed an insignificant 1% decrease ($p = .91$) with the current group of 4th-year students achieving a mean score of 69% (SD = 9.1) compared to a mean score of 70% (SD = 9.0) for the previous cohort (a bare pass on these criterion-referenced examinations is 50%). Comparing the final examination performance of the current 4th-year students with their own performance at the end of their 3rd year, did demonstrate a 3% increase ($p < .001$) with the mean Diagnostic Imaging examination score in year 3 being 72% (SD = 10.7).

DISCUSSION

Students rated all three methods of presenting educational material (lecture, small-group tutorial, and self-assessment exercise) as "above average" in usefulness. The small-group tutorial and the lecture were rated close to the maximum value of 5, indicating that students value both of these as "very useful" learning tools. In terms of the actual ranking of these three educational methods, over half of the students (56%) chose the "small-group tutorial" as most useful, followed by "lectures" (28%). Although the self-assessment exercises were felt to be the least useful of the three presentation methods, they were still rated above average. The high rating for the "lecture" method in this subject supports the use of the interactive lecture format, which is how these lectures are presented, as compared to the old-fashioned didactic approach to lecturing (11). Interactive lectures involve student participation by asking frequent questions based on the material covered or making students frequently use the presented information in clinical scenarios during the lecture. Lectures have received much criticism in the literature in the past few years and some educators strongly feel that this traditional method of teaching should be abandoned (11). The results of this study do not support this idea and in fact offer some comfort to those who recognize the value of appropriately delivered lectures in presenting important concepts and background information to large groups in an interactive and timely fashion. These lectures can then form the foundation for subsequent work in small-groups, laboratories, or directed learning exercises.

It is not surprising that the students ranked the self-assessment exercises as their least favorite learning tool of the three options provided. As Paul et al. (6) noted, medical students prefer a close relationship with the teacher. This is most likely true for all students, and with the self-assessments, students are on their own in the laboratory. Furthermore, students must be organized and motivated to get into the learning laboratory during the week to complete these exercises. As one student commented on the open section of the questionnaire:

> I know that tutorials take up your time and you are very busy, but I found that you have to be very motivated to do the self-assessments and if you miss them then it can be hard to catch up on material covered.

However, one of the benefits of the self-assessment exercises is in offering the students the opportunity to practice time management. It is totally up to them whether or not they do any of these exercises and when during the week they complete these tasks. In contrast, students are required to attend at least 80% of the small-group tutorials. In total, 73% of the students stated that they completed the self-assessment exercises "always" or "usually," leaving 27% of the students doing them only half of the time or even less often. Fittingly, a trend was found (although not significant) that those who completed the assessments less often obtained lower test scores. However, this may reflect a lack of motivation by those students in general rather than specifically for this method of learning. One student who appreciated this flexibility of the self-assessments as well as the intended learning outcomes, wrote the following:

> The lectures point out all of the key points to be observed. The small-group sessions put our observation skills to test (build on the lecture). Self-assessments show where we need to do more work. You can do these when you have

an hour off. You can also look again later in the week to review the cases you missed.

Another potential reason for student preference of small-group tutorials over the self-assessment exercises may lie in the way that the small-group sessions are structured and presented. These are all film-reading, problem-solving exercises in which the entire small group sits around the view boxes with the tutor discussing several cases relevant to the current material being covered. Clinical information (i.e., history and physical examination details) are linked to imaging findings. Follow-up procedures are discussed and chiropractically relevant management decisions are debated. Students can get any questions or "hallucinations" answered immediately. The teaching environment is very interactive and "safe" with no questions or answers considered inappropriate. In fact, students are encouraged to make mistakes in this safe learning situation, as that is how they remember for future use. The tutor in this situation is a "facilitator" and does not provide a "mini-lecture." The students are expected to have attended the relevant lectures, or studied the material in advance. Both the students and the various tutors have found this format of teaching and learning fun and very efficient in terms of covering a large number of cases and answering many different student questions or addressing their concerns in a timely manner. It is also a much more efficient method for answering student questions than the commonly used method in chiropractic colleges of simply placing radiographs in a lab for students to study and having a faculty member available to answer questions. The tutor in that situation finds that he or she is answering the same question over and over rather than addressing many different issues. However, the small-group tutorial method is not efficient in terms of tutor contact time. At colleges where time constraints on the faculty are nearly at breaking point, as at the AECC, the luxury of weekly small-group tutorials may not be feasible. For this reason the self-assessment exercises were tried and appear to be a valid substitute for some of the small-group tutorials. However, completely eliminating the small-group tutorials would be a pity as they provide the tutor with instant feedback as to how the students are progressing, the students love them, and they are also enjoyable for the tutor due to the interaction with the students.

In addition to the reduction in tutor contact time and flexibility for the students in performing these exercises, other benefits of the self-assessment exercises were envisioned prior to their creation and thus built into the cases. These learning tools were specifically designed to engage the student in a problem-solving exercise, which required their participation and decision making on clinically relevant cases. Each case was presented as close to a clinically real situation as possible and required short answer responses, as would occur in a practice setting, rather than asking multiple-choice questions (MCQs). This format was chosen to teach students to think and function like clinicians on cases similar to those that may present to their offices in the future. The students are forced to make decisions on their own without the support of the group or the 'cueing effect' of MCQs (12). This again simulates the realities of clinical practice and thus reinforces the importance of the material being learned (3). The self-assessment exercises also emphasize the role of radiology in chiropractic practice and help students to see that imaging does not stand alone but is integrated into the diagnosis of the patient in appropriate cases. These exercises can also be used to illustrate cases when diagnostic imaging may not be indicated or particularly useful—again simulating real clinical practice and facilitating the development of rational decision-making processes in the student.

A detailed answer scheme was provided for each case which not only answered the specific questions asked, but often included additional relevant radiographic or clinical information which was deemed important to the concepts illustrated. One appreciative student wrote on their questionnaire: "Very helpful are the *management comments* since you can't find that really in the radiology text books."

The answer schemes were attached to the back of each paper and the students were instructed not to look until they had arrived at their own answers. The value of the exercises lies in the fact that they provide instant feedback to the students so that they receive frequent evaluations of their individual performance. Astute students should become immediately aware of areas of strength and weakness. The answer schemes also give the students written examples of how to professionally use the radiographic terminology.

MCQs were not used for any cases because MCQs do not reflect clinical reality. Radiographs do not emerge from the processor with four or five choices!

Clinicians must make their own decisions after thorough evaluation of the films and linking of the key abnormal findings with the relevant clinical information. MCQs may be easy for students to answer and easy for faculty members to mark, but current research confirms the long-held suspicion that they are not very effective in measuring higher cognitive skills (12–14), those very skills required from a primary health care professional. Webber (14) highlights the benefits of short answer questions as an alternative to MCQs, adding that this form of inquiry more closely reflects participatory teaching and self-directed learning. In addition, short answers have sufficient precision as to be fairly easy to mark.

Although a slight majority of the students would have preferred to have only small-group tutorials, nearly half (48%) appreciated the self-assessments, either alone, or more commonly in combination with the small-group sessions. It is extremely important to point out to the students and other educators that the use of the self-assessment exercises did not have a negative impact on the in-class test or final examination results. Comparing the current 4th-year exam results with those from the previous cohort of 4th-year students showed no significant difference. In fact, for the first time in 10 years, no students from the 4th-year cohort failed the final examination. (Typically three or four students failed this examination in any given year previously.) However, while the performances were no worse, the mean exam score was also no better, in spite of having no failures. Considering the overall potential savings in tutor contact time, this is a very favorable result.

One could suggest that the reason that there was no significant difference in examination performance between the two cohorts and why no student failed in the current year is because the final examination was easier this year than last. All examinations at the AECC are both internally and externally peer-reviewed for case content, case mix, answer schemes, relative weighting of marks, and difficulty levels. Additionally, a profile of papers are triple marked (i.e., three different examiners mark the same papers) to assure consistency of marking procedures. If anything, the examination for the current cohort was more difficult than for the last group of students as more in-depth clinical questioning was included for this year. The format of these examinations, including the short answers required, is exactly the same as the format used in the self-assessment exercises, although obviously with different cases and questions. This may also explain the fact that no failures occurred in the present cohort of students. They had been offered approximately 14 different "practice" sessions throughout the year with instant feedback via the answer schemes. Also, one cannot exclude the contribution that an inherent variation in the ability of the two student cohorts may have had on the results.

The final film-reading examinations are 15-station, 2-hour papers containing over 20 different pathological conditions. Cases are weighted according to the seriousness of the pathologies demonstrated, or number of different conditions to be identified. Students are unaware of the relative weighting of each case during the examination and the marking is criterion referenced. Thus these exams should be valid representations of the students' abilities in diagnostic imaging as the literature states at least 10 cases are needed in order to assure validity for problem solving or clinical examinations (15).

A possible reason that the self-assessment exercises were less popular than the small-group tutorials or lectures is student anxiety in not having frequent contact with the tutor and thus fear that they may not learn as much or perform as well. Feedback to the students that examination performance did not deteriorate should help to alleviate this anxiety and thus increase the popularity of the self-assessments for future cohorts.

The current group of 4th-year students achieved a mean final examination score 3% lower than their performance in the 3rd-year diagnostic imaging exam. This did reach statistical significance, and may reflect a negative effect of the self-assessment exercises, or simply be due to the fact that the 4th-year examination is comprehensive over all previous diagnostic imaging material, including that studied in the 2nd and 3rd years of the course. Thus the students had a much broader range of material over which to study and demonstrate competency. In order to determine which of these factors is responsible for the difference, comparisons need to be made with previous cohorts. This was not done as a 3% difference, although statistically significant, is not particularly educationally significant.

This study also demonstrates how fundamentally easy it can be to research, in a scientific manner, educational interventions and their costs/benefits. Evidence-based medical and chiropractic education is becoming as important as evidenced-based practice, and educators cannot afford to ignore this trend (16).

CONCLUSION

No difference in examination performances was found comparing students who experienced self-assessment exercises alternating with small-group tutorials, with students who had weekly small-group tutorials. The dramatic savings in tutor contact time after the initial outlay of work to create these structured learning tools is therefore justified. A combination of small-group tutorial and self-assessment exercises is the preferred method of delivery of course materials as both methods provide different educational experiences.

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