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Introduction of a Novel Teaching Paradigm for Head and Neck Anatomy

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ABSTRACT (Email Abstract) INTRODUCTION:

Didactic head and neck anatomy teaching has been replaced by a novel self-directed, multimodal, and multidisciplinary approach at the Schulich School of Medicine and Dentistry (SSMD).

OBJECTIVES:

To describe the use of a novel teaching paradigm at SSMD and to enable readers to determine how this methodology may benefit medical students at other academic institutions and disciplines.

DESIGN:

Prospective cohort study.

METHODS:

The paradigm consists of multimedia learning modules to guide independent anatomy learning. Students received a case-based assignment based on the content of the learning modules to guide them through cadaveric dissections facilitated by a multidisciplinary team of surgeons and anatomists.

MAIN OUTCOMES MEASURES:

Primary outcome: Postcourse survey and mean scores comparison. The survey collected data, including demographics and previous anatomic and computer-assisted learning (CAL) experiences, and focused on measuring student perception of the proposed paradigm. Secondary outcome: Correlation of demographics.

RESULTS:

The paradigm was successfully implemented and warmly received, but it still requires further development. Although CAL allows increased individual engagement, students still enjoy and value lectures. In addition, students view instruction by surgeons in laboratories as the most valuable component of their anatomy teaching as it not only deepened the students' understanding of anatomic structures but also provided them with the clinical relevance. Technological innovations were welcomed by the students but have not replaced their appreciation of dissection and lecures.

Translated Abstract Sommaire INTRODUCTION:

L'enseignement magistral de l'anatomie de la tête et du cou a été remplacé par une nouvelle approche autodirigée, multimodale et pluridisciplinaire è la Schulich School of Medicine and Dentistry (SSMD).

OBJECTIFS:

L'étude avait pour objectifs de décrire l'application d'une nouvelle formule d'enseignement è la SSMD et de montrer aux lecteurs comment la nouvelle méthode pouvait aider les étudiants en médecine dans d'autres établissements universitaires et dans d'autres disciplines.

TYPE D'éTUDE:

Il s'agit d'une étude de cohortes, prospective.

MéTHODES:

La formule se composait de différents modules d'apprentissage multimédia, visant è permettre l'apprentissage autonome de l'anatomie. Nous avons donné aux étudiants un devoir basé sur des cas et sur le contenu des modules dans le but de les guider dans les dissections de cadavres, éclairées par une équipe pluridisciplinaire de chirurgiens et d'anatomistes.

PRINCIPAUX CRITàRES D'éVALUATION:

Le principal critère d'évaluation consistait en l'enquête apràs le cours et dans la comparaison des résultats moyens. L'enquête portait, entre autres, sur des données démographiques et sur les expériences antérieures del'étude de l'anatomie et de l'apprentissage assisté par ordinateur (AAO), et plus particuliàrement sur la mesurede la perception des étudiants è l'égard de la formule proposée. Le critère secondaire d'évaluation consistait en la corrélation entre différentes données démographiques.

RéSULTATS:

La mise en ouvre de la nouvelle formule a été réussie, et, bien que celle-ci doive encore être améliorée, les étudiants se sont montrés grandement intéressés. L'AAO favorise un engagement personnel accru, mais les étudiants aiment toujours les cours magistraux et les trouvent tràs utiles. De plus, les étudiants considàrent l'enseignement donnéen laboratoire par les chirurgiens comme l'élément le plus important de l'enseignement de l'anatomie, non seulement parce qu'il leur permet d'approfondir leurs connaissances sur les structures anatomiques, mais parce qu'il revêt une pertinence clinique. L'innovation technologique a certes suscité l'intérêt des étudiants, mais pas au point de supplanter les dissections et les cours

magistraux.

Keywords
computer-assisted learning, head and neck anatomy, undergraduate medical education.

According to the standards set out by the Liaison Committee on Medical Education (LCME) and the Committee on Accreditation of Canadian Medical Schools (CACMS), medical education programs in Canada and the United States must include instructional opportunities for active learning and independent study to foster the skills necessary for lifelong learning.**1** Independent assessment, analysis, and evaluation of information are among a growing set of skills necessary for lifelong learning. Use of these skills is encouraged in students through participation in active learning environments such as laboratories and critical appraisals. Hands-on, active learning environments can be integrated into the MD curriculum with initiatives including computer-assisted learning (CAL), simulated exercises, and laboratories where the students can assemble or evaluate hypotheses of physiologic phenomena., **1** At the Schulich School of Medicine and Dentistry (SSMD), University of Western Ontario, in London, Ontario, these initiatives have become increasingly important with recent trends toward decreased lecture hours, necessitating additional hours of nonlecture learning.

Hours devoted to anatomic study in the SSMD undergraduate medical curriculum have decreased significantly over the past several years. Like many other contemporary medical school programs, SSMD has adopted a more integrated, systems-based approach, which is reflected in increased self-directed and problem-based learning, at the expense of lecture hours and laboratory exercises.

CAL has great potential to augment anatomy teaching and includes inherent advantages such as portability, standardization, reusability, and increasing feasibility of distance education. Several studies have shown that basic patient management can be taught as effectively with a computer module as with a small-group interactive seminar and in a manner superior to standard classroom instruction.**2–7** This is bolstered by the responses of the students, a majority of whom indicated that they enjoyed their computer conferencing experiences., **3** CAL is a feasible, effective, and efficient means of enhancing self-directed learning as supplementation to the preclerkship undergraduate otolaryngology curriculum., **5**

At SSMD, head and neck anatomy is taught primarily in the ear, nose, and throat (ENT) section of the respiration and airways course. This 5-week course is divided anatomically into the lower airway (3 weeks) and the upper airway (2 weeks). Head and neck anatomy is restricted to the latter 2-week period, limiting students' exposure to this subject. Furthermore, lecture hours for the basic sciences and clinical topics are presently limited to a maximum of 3 hours per day in the entire preclerkship curriculum as mandated by the SSMD curriculum committee, presenting further challenges to the teaching faculty and students.

Student feedback and performance from the past 2 years at SSMD have demonstrated clearly that there is a need for additional teaching in head and neck anatomy, given its inherent complexity. We therefore proposed the introduction of a novel teaching paradigm. The objective of this study was to develop a teaching paradigm for head and neck anatomy that is multidisciplinary and addresses multiple modes of learning:

1. Prelaboratory, Web-based, computer-assisted instruction
2. Integrated anatomy laboratories, taught jointly by basic science and clinical faculty
3. Postlaboratory classroom-based instruction on clinical application

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Materials and Methods

In this pilot project, computer, laboratory, and classroom-based learning materials were developed and introduced into the undergraduate medical curriculum. Student perceptions were then assessed.

Prelaboratory Computer-based Learning Modules

A team of graduate students in the Department of Anatomy and Cell Biology and undergraduate medical students at SSMD worked together to develop these modules. The learning materials consist of selected text and two-dimensional images from existing lecture notes, three-dimensional computer models, and video clips describing anatomic features on plastic models and cadaveric specimens. Students were also given access to three-dimensional interactive animations via “Anatomy TV” (a link from the University of Western Ontario's Taylor Library) and a CD study guide, which contained notes, interactive animations, and two-dimensional images. The content of the module was determined by existing objectives, set by a curriculum committee, and was designed to give students a basic overview of the structures to be examined in the laboratory. The content also served to highlight the objectives of the laboratory and had the following features:

- Interactive
- Multiple modalities (text, images, movies), to allow multiple learning styles to be stimulated
- Integrative (histology, imaging, surface anatomy, clinical applications to otolaryngology)

WebCT Vista (an online course management system) was used to deliver the materials and allows students to revisit materials and resources when or if required, from any location with an Internet connection. Students were strongly advised to complete this module prior to attending the laboratory.

Development Of Integrated Anatomy Laboratories

These consisted of objective-driven laboratory experiences that covered content that was not taught in lecture and were supervised by teaching assistants and faculty from the Department of Anatomy and Cell Biology, as well as surgeons from the Department of Otolaryngology–Head and Neck Surgery. A case-based assignment was developed that corresponded to the learning objectives and consisted of data collection and problem solving that highlighted specifics of the objectives and encouraged independent discovery. The assignment was handed in at the end of the laboratory, marked, and returned to the students as feedback.

Student Feedback Questionnaire

Students were required to complete a 35-item questionnaire that inquired into demographics, previous anatomic and computer-based learning experiences, and the students' subjective perception of the proposed teaching paradigm. A two-tailed *z*-test of comparing proportions was done to assess possible correlations.

Participants included first-year (preclerkship) medical students. There were no participant exclusion criteria.

Subgroup analysis was performed to determine whether students who have taken a human anatomy course in the past have a different learning preference than students without an anatomy background. Analysis and a two-tailed *z*-test of comparing proportions were also carried out to compare

the responses between males and females to determine whether gender plays any role in learning style preference. Research Ethics Board approval was obtained for the comparisons.

Results

The average age of the surveyed students was 23.1 years. The response rate was 66.7% (98 of 147 students). Some respondents chose not to answer all questions, and of the 98 returned questionnaires, four respondents chose not to answer any of the questions, although they provided comments on how the course can be improved; 47.9% of respondents had previously completed a human anatomy course (**Table 1** and **Table 2**). A 5-point Likert scale was used to assess the comfort level of the students in head and neck anatomy prior to the introduction of the course. The median was 1 (1 = low comfort, 5 = high comfort).

Table 1
Demographics

Table 2
Self-Reported Percentages of Attendance

Twenty of 93 respondents (21.5%) did not use the modules. Most of the students did not have technical problems while using the modules (median = 4; 1 = “I couldn't use it at all,” 5 = “I did not have any trouble”). Overall, students felt that the modules were well organized (median = 4, *n* = 94; 1 = poorly organized, 5 = well organized) but that too much material was presented (median = 4; 1 = too little material, 5 = too much material). Participants found that the modules were taught at an appropriate level (median = 3, *n* = 94; 1 = too elementary, 5 = too advanced).

Respondents felt that this module contributed significantly to their understanding of upper airway anatomy (median = 4, *n* = 94; 1 = “nothing,” 5 = “everything I know about upper airway anatomy”). Respondents felt that computer-based modules were valuable for teaching clinical anatomy (median = 4, *n* = 94; 1 = “useless,” 5 = “very valuable”). Seventy-one of 90 respondents (78.9%) preferred to learn by attending lectures. Fifty-two of 90 respondents (57.8%) preferred to learn by self-directed exercises. Respondents seemed neutral toward the value of lectures in comparison with computer-based modules for teaching clinical anatomy (median = 3; 1 = lecture more valuable, 5 = computer more valuable).

At the completion of the course, the students using the new teaching paradigm were moderately comfortable with the anatomy of the head and neck (median = 3, *n* = 94; 1 = low comfort, 5 = high comfort). The majority of respondents stated that they use computer-based learning often or always (48.7%); 24.4% of respondents stated that they never or infrequently use computer-based learning, whereas 26.9% of respondents stated that they sometimes use computer-based learning. Most of the respondents stated that their preferred learning style is visual (56.8%), followed by hands-on (33.7%) and auditory (9.5%).

Overall, given that the time for teaching anatomy is limited, the students were asked to designate specific proportions of time to four different learning modalities to design a hypothetical “perfect curriculum” (**fig1**):

Figure 1
The “perfect curriculum.”

- Lectures, 32%
- Laboratories, 31%
- Computer teaching, 15%
- Tutorials with clinicians present, 22%

Students reported that the combination of clinical and basic science teaching faculty as well as the anatomy laboratory was most effective in helping them learn head and neck anatomy (median = 4 on a Likert scale; 1 = not effective, 5 = very effective). The students reported that the prelaboratory computer module was less effective in comparison (median = 3). The laboratory assignment was reported to be relatively ineffective in helping to learn head and neck anatomy (median = 2, *n* = 94).

The students were also asked to provide suggestions on how to improve their learning experience for the future. The most common recommendations included the following:

- Inclusion of didactic lectures (20 of 60)
- Removal of the laboratory assignment (14 of 60)-students commented on the clinical nature of the assignment and that there was little time, especially if the student did not review the modules, to learn the basic anatomy in the laboratory
- Improvement of the technical aspects of the Web modules (eg, being able to rewind the online videos, Macintosh compatibility) (14 of 60)
- Inclusion of accompanying printable notes to the Web modules (13 of 60)
- Better overall organization of the course (9 of 60)

The results of subgroup analysis demonstrated that there was no significant difference in the learning preferences between participants with prior anatomy experience and those without it (**Table 3** and **Table 4**). No significant difference was found between gender subgroups for either preference for lectures or preference for self-directed exercise (**Table 5** and **Table 6**).

Table 3
Prior Anatomy Course versus Preference of Lectures

Table 4
Prior Anatomy Course versus Preference of Self-Directed Exercises

Table 5
Gender versus Preference for Lectures

Table 6
Gender versus Preference for Self-Directed Exercises

No difference between subgroups was demonstrated with respect to the perceived value of computer-based modules for teaching clinical anatomy in comparison with lectures (median = 3 of 5 on a Likert scale for both groups; 1 = lecture more valuable, 5 = computer more valuable).

Discussion Survey Response Rate

The response rate of 66.7% was good.**8** The questionnaire was distributed and completed on paper. Students were given the questionnaire at the end of the final laboratory session and were requested to return the questionnaire to the laboratory instructor so that the students could not merely set the questionnaires aside at home. This could explain the high response rate. However, studies have shown no difference in the response rate between paper-based questionnaires and Web-based questionnaires., **9–13** There was good representation of students both with and without prior anatomy experience as well as students of both genders.

It appears that students from both groups-with and without prior anatomy experience-were not very comfortable with head and neck anatomy prior to the introduction of the course. The fact that students felt that too much material was presented correlated strongly with the low comfort level with head and neck anatomy. Although the majority of respondents hold a bachelor of science or medical science degree, there appeared to be very little, if any, otolaryngology representation in the undergraduate anatomy curricula at Canadian universities attended by SSMD medical students.**14,15** Given the high prevalence of head and neck diseases encountered in general practice, there is considerable value to adequately educating medical students about head and neck anatomy., **14,15**

Effectiveness of Self-directed Learning

Although the new teaching paradigm requested students to use the computer modules to prepare for the anatomy laboratory, 21.5% did not use the modules. Although the LCME advocates self-assessment on learning needs and independent identification of relevant information, a significant proportion of respondents chose to bypass simulated prelab exercises.**1** Although previous studies have shown that CAL is both effective and enjoyable,, **2–5,7** students who do not use the modules could not benefit from CAL. Although CAL has been demonstrated to be well received by students, students in our study may have perceived it as a noncompulsory task to be completed in addition to their daily studies. With time, the students may grow to appreciate the value of CAL. Given that the modules were designed to contribute to the objectives of the course and to aid in enhancing the students' ability to collect, analyze, and integrate anatomy knowledge, the 21.5% of respondents who did not use the modules may have missed the opportunity to address relevant clinical anatomy with hands-on and simulated exercises.

Value Of Standard Classroom Lecture Versus Computer-based Modules

The results of our study suggest that students seem to value traditional classroom-based learning. When asked to provide suggestions on how to improve their learning experience for the future, the most common recommendation was the inclusion of didactic lectures. However, when asked about the relative value of lecture versus computer-based modules for teaching clinical anatomy, the students felt neutral. As for what the students find most valuable, a middle-ground approach in the balance of lectures versus computers seems to be preferred (see **fig1**).

Effectiveness of Surgeons Teaching Anatomy

With respect to the different modalities used in the novel teaching paradigm, the students reported that the combination of clinical and basic science teaching faculty as well as the anatomy laboratory was the most effective in helping them learn head and neck anatomy. The introduction of surgeons filled much-needed teaching slots in the anatomy curriculum, helping to integrate self-directed learning, traditional cadaver dissections, and, more importantly, clinical correlation of the students' basic science knowledge. The presence of surgeons at this early stage of the curriculum allows students to gain an early appreciation for surgery and to see the practical and clinical importance of anatomy.**16**

Case-based Assignment and Integration

The case-based assignments accompanied the integrated anatomy laboratories. The assignments were developed to correspond to the objectives of the course. Successful completion of the assignment required students to collect, analyze, and assimilate information learned in the laboratory and through the computer-based module. The intention was that by completing the assignments, the students are able to heighten their sense of discovery in addition to highlighting information set forth in the course objectives. However, the lab assignment was reported to be relatively ineffective in helping to learn head and neck anatomy. It is possible that one limiting factor for the success of this assignment as a learning tool was the expectation that students were to hand in the assignment on the day of the laboratory. We postulate that first-year medical students may have had difficulties integrating the knowledge required to complete the assignment without first having developed a strong foundation in anatomy.

Gender and Past Anatomy Course Versus Learning Preference

Our study suggests that there was no relationship between whether or not the students had past anatomy experience and learning preference. Furthermore, no correlation was found in gender and preferred learning style. Our findings are in contrast to those of previous studies measuring gender differences in learning style preferences among first-year medical students and undergraduate physiology students.**17,18** Slater and colleagues in 2007 administered the visual, auditory, reading/writing, kinesthetic (VARK) questionnaire to first-year medical students at Wayne State University School of Medicine., **18** With a response rate of 38.8%, female students were noted to be more diverse in sensory modality combinations within their preference profiles. Wehrwein and colleagues' study showed a different finding., **18** The VARK questionnaire was administered to undergraduate physiology majors enrolled in a capstone physiology laboratory at Michigan State University, and 54.2% of females and only 12.5% of males preferred a single mode of information presentation. Male students were evenly distributed in preference. Our study shows that both male and female students equally enjoy self-directed studies and lectures, with a higher preference toward lectures in both genders. There was no statistically significant difference between the male and female population in our study. Murphy and colleagues demonstrated similar findings., **19** In their study, a learning preference survey linked to sensory modalities was given to students in the four classes of the Temple University School of Dentistry. The results showed no significant differences between genders. A possible explanation for such differences in studies is that in our study, the module

incorporates many learning styles but has the flexibility to allow users to concentrate on materials through the style of their choosing. Therefore, it is difficult to illustrate a statistical difference among users.

Conclusion

The introduction of an integrated systems-based curriculum at SSMD has necessitated a reduction in the number of lectures in teaching head and neck anatomy. In the new teaching paradigm, students learned the anatomy of head and neck using CAL multimedia and dissection laboratories taught by basic science and surgical clinical faculty. The new teaching paradigm was successfully implemented and warmly received, but it still requires further development. Although computer-assisted instruction allows increased control and individual engagement, students still enjoy and value lectures. In addition, students seemed to view instruction of surgeons in anatomy laboratories as the most valuable component of their anatomy teaching. Having ENT surgeons in the dissection laboratory not only deepened the students' understanding of anatomic structures but also provided them with the clinical relevance and aids in recalling the three-dimensional structures. Technological innovations introduced in the new teaching paradigm were welcomed by the students but have not replaced their appreciation of dissection and didactic lectures.

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