Blended Learning in Orthodontic Diagnosis: An Interactive Approach

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SOMMAIRE

Les programmes multimédia interactifs offrent la possibilité d'un véritable apprentissage, tant à l'intérieur qu'à l'extérieur de la salle de classe. L'Université McGill a conçu un programme interactif de diagnostic orthodontique sur CD-ROM, que la Faculté de médecine dentaire utilise avec succès pour offrir aux étudiants du premier cycle des tutoriels et des exercices interactifs visant à les aider à reconnaître les malocclusions en formation. Ce programme multimédia se distingue notamment par l'utilisation d'une démarche globale pour l'enseignement du diagnostic, ainsi que par sa solide conception pédagogique qui prévoit des séances pratiques interactives et assure une rétroaction aux étudiants. Le but de ce programme interactif est de combler l'écart entre l'enseignement théorique et les compétences pratiques qu'il est impératif d'acquérir pour exercer la profession de dentiste avec succès.

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The more active students are in the learning process, the greater their learning.[1–6] Active learning environments, such as laboratories, give students an opportunity to practise much of their theoretical knowledge and develop the practical skills they require to be successful in dentistry. In these environments learning must often be allowed to occur at an individual pace, as not all students progress at the same rate. This can be a challenge in face-to-face situations.[7,8] However, computer-assisted instruction can provide unique opportunities for self-directed learning by focusing on interaction, practice and feedback.

In the early 2000s, after a careful review of the orthodontic curriculum at McGill University, we decided to incorporate a multimedia, self-directed learning module, Orthodontic Diagnosis, into our curriculum. The main goal in using this approach was to enhance learning by letting students work at their own pace, reviewing the various concepts and practice exercises on their own outside the traditional laboratory environment. An additional issue we wished to address was frequent complaints from students who had difficulties finding information relevant to their training in conventional textbooks, as these were designed primarily for postgraduate students.

In an undergraduate dental curriculum, one of the most important goals of the orthodontic division is to train future dentists to recognize and appreciate the severity of malocclusions. No textbook presents a systematic approach to this aspect of undergraduate training. Delivering content by lecture alone is insufficient as this does not allow for the practice and feedback that is necessary to improve practical skills.[1,6]

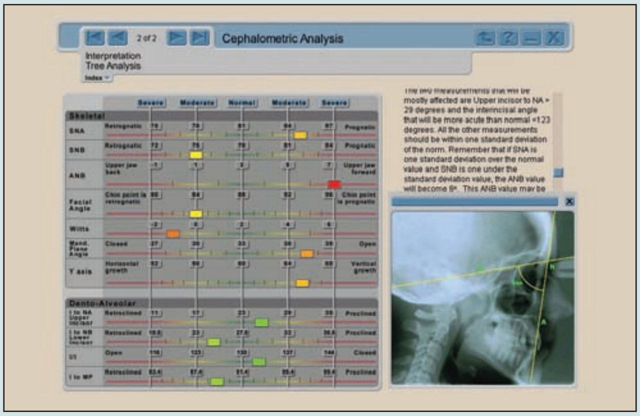

Figure 1: An interactive table illustrates the interrelations between various diagnostic measurements.

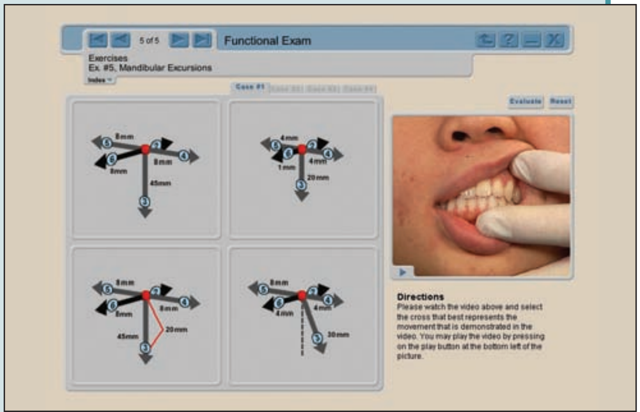

Figure 2: Video simulations illustrate examination techniques and elicit feedback from the student.

Design and Development

Orthodontic Diagnosis software, comprising several units, was developed by McGill University and Dr. Jean-Marc Retrouvey. Created by a team of instructional designers, the learning modules incorporate important educational tools to allow students to understand the complexities and variability of an orthodontic diagnosis and provide them with an opportunity for authentic learning and feedback. In 2005, this interactive program won a Bronze Media Festival Award from the Health and Science Communications Association.

Dentistry students often have difficulty bridging the gap between theoretical knowledge and the practical skills they need for successful diagnosis of developing orthodontic problems. They often lack a whole-patient approach and overfocus on technical details. In our software program, multimedia content is combined with practice and feedback to give students individual opportunities to practise important concepts. Electronic tools were developed to simulate real instruments used in conventional diagnostic procedures, creating a virtual laboratory to assist in diagnosis.

On completion of the modules, students were expected to be able to recognize and identify a developing malocclusion, identify differences between normal and abnormal development, identify and apply the necessary diagnostic tools at the appropriate time and effectively diagnose a developing malocclusion.

Outside-in Approach

An "outside-in" approach to orthodontic diagnosis is taken, rather that relying on dental casts and radiographic observations alone. Before observing the dental occlusion, students are taught to examine the facial structures, the functional envelope of the orofacial complex and the complexities of the masticatory and orofacial musculature to obtain a complete picture of the patient's problem. Facial features as well as neuromuscular patterns must be examined thoroughly before a dental examination is performed. Similarly, panoramic and cephalometric analyses are important tools to obtain full information before arriving at a correct diagnosis.

Instructional Design

An effort was made to follow exposure to specific content with effective opportunities for practice, a key element in the success of the learning materials. Learning objectives were aligned with the presentation of interactive content and opportunities for practice and feedback were provided.[6,7,8]

The instructional design model followed in the project consisted of the following phases:

- Analysis: Determine what is to be learned, by whom and what skills need to be acquired.
- Design: Determine what types of learning experiences will be available for learners to achieve the goals of instruction.
- Development: Write and produce interactive materials, often with the assistance of professional programmers.
- Implementation: Select a few learners to test the program to determine what is effective and what needs to be improved.
- Evaluation: Gather data to support the efficacy of the project and determine how well learners are able to achieve instructional goals.[9]

Interactive Content

Interactive Tables

Interactive tables (**Fig. 1**) provide students with the opportunity to explore how various values shift based on changes in other areas.

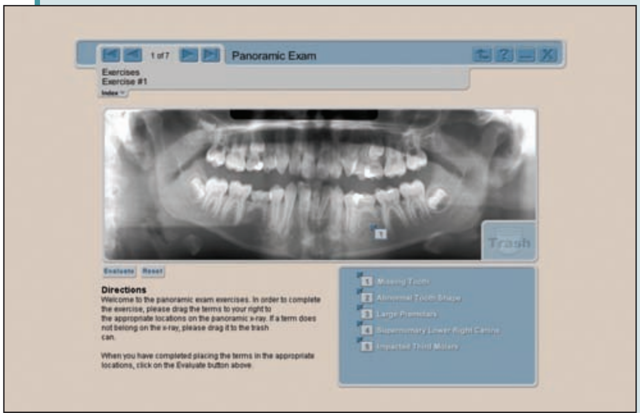

Figure 3: Drag and drop features allow students to identify structures and features and receive an immediate evaluation of their accuracy.

Figure 4: Instruments, such as the Boley gauge, are simulated to permit students to make virtual measurements on a sample dental cast displayed on screen.

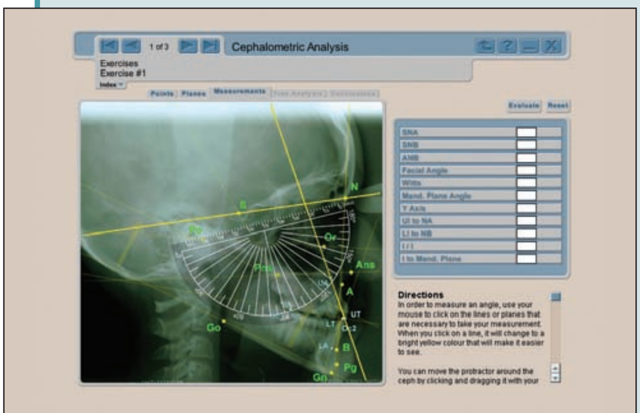

Figure 5: A simulated protractor is used for cephalometric analysis.

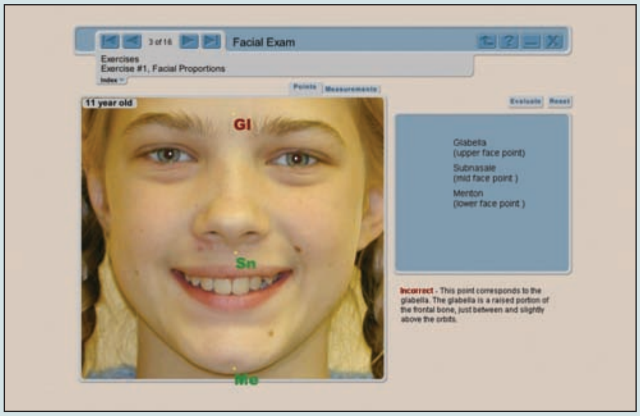

Figure 6: Green-, orange-, red-light exercises are used to quiz students in simple exercises, such as this one on observing facial proportions.

Video Simulations

Video simulations (**Fig. 2**) were introduced to illustrate mandibular range of motion. Several articular disorders are simulated and the student is asked to find the mandibular displacement for each as well as the probable cause for the limited range of motion of the mandible in the test case. This process creates a controlled learning environment in which the student can understand a concept and practice it several times.

Practice

To allow students the opportunity for authentic learning, a number of computer tools were developed to simulate those they would use in practice.

Drag and Drop

A drag and drop tool (**Fig. 3**) allows students to practise recognition of structures and pathology. Students can identify anatomical structures in a safe, learner-controlled environment.

Boley Gauge

A virtual Boley gauge (**Fig. 4**) was developed to standardize exercises specifically for Bolton and Moyers' analyses. This tool and properly scaled dental casts allow students to practise from home and remove the need for an inventory of study casts. Three-dimensional models were a possibility, but were not used because of the high cost at the time of development and the fact that conventional plaster casts are still used in most dental practices.

A movable protractor (**Fig. 5**) allows students to learn and practise cephalometric analysis. Dental students as well as general practitioners do not routinely trace cephalometric radiographs. This exercise was mainly designed to introduce students to the diagnostic power of cephalometric analysis and allow them to practise on a computer model. In the future, we hope to incorporate tracing software, which is becoming more common.

Green-, Orange- and Red-Light Exercises

Students often voice the concern that they are not properly trained to recognize the complexity of a malocclusion. They do not appreciate the interactions between the various observed parameters that can guide them in the evaluation process. Breaking the information down into smaller pieces allows students to master more easily attainable goals before proceeding. In the interactive program (**Fig. 6**), observations are organized into categories and assigned a colour: green signifies that the observed parameter is normal and will probably not contribute significantly to the malocclusion; orange means that the parameter is 1 standard deviation from the norm; and red signifies a potential problem that will require careful investigation by the learner.

Feedback

One of the most important aspects of the modules is the individual feedback that each student receives based on his or her work on the exercises. Feedback is provided after each question, directing the student if the answer is wrong or reinforcing the acquired knowledge. Breaking the exercises down into small sections and providing feedback after each section promotes mastery learning, a pedagogic method in which students master a step or concept before they are allowed to move to the next level.

An important aspect of this "formative feedback" during the learning process is that it allows students to practise and make corrections in a controlled environment before they are asked to perform the task in a test situation. The form of the feedback is not merely "correct" or "incorrect," but rather detailed responses on why a particular choice is correct or not and how students can improve their skills for the next exercise.

Key Advantages

This multimedia program has been well received by students as it allows them to learn at their own pace and apply the knowledge by carrying out simple but effective exercises. It is not designed as a textbook, but rather as a logical process within the framework of examination and accurate diagnosis of an orthodontic patient. Following an instructional design and development process is an effective method for producing an end product that is not only engaging to students, but also helps them learn the key elements of orthodontic diagnosis.

Other advantages include the transfer to a virtual environment of repetitive concepts, such as cephalometric analysis. Didactic classes on this topic have been completely eliminated and students are actually performing better using the technology than they did after traditional lectures and laboratories. Using the program, they can complete a cephalometric analysis without supervision or instructor assistance.

Evaluation of the Program

Another Canadian university has tested the Orthodontic Diagnosis software and preliminary reports are encouraging. Students like the concept and their rate of learning and retention of knowledge seem superior to those using conventional lecture-type delivery. These results are supported by the literature, which suggests that it is critical for students to be active learners and to be provided with practice opportunities and feedback during the learning process, rather than information only.[7,8]

Impact on McGill University's Dentistry Program

Initially, the modules were designed as a self-directed learning tool for full-time students enrolled in an undergraduate dental program. However, experience has shown that simply providing students with the modules was not enough; the students wanted more support from teaching staff. Now the modules are used in a more blended fashion, both inside and outside the classroom. "Blended learning is learning that is facilitated by the effective combination of different modes of delivery, models of teaching and styles of learning, and founded on transparent communication amongst all parties involved with a course."[10]

Lectures are supporting the content of the modules, and the modules are being used extensively for case presentation in third- and fourth-year classes. Each student has to present an orthodontic case to the rest of the class and the instructor provides feedback, not only on the observed case but also on the way data are gathered and used. This method standardizes case presentation seminars and eliminates confusion among students by providing a consistent way to deliver data pertinent to the patient's orthodontic diagnosis.

Students benefit from lectures based on the design and order used in the multimedia software; they carry out exercises in each section and are then asked to combine their new knowledge in a case presentation to their class. Every case presentation must follow the design and order (red, orange and green light concept) used on the CD. This approach standardizes the process, allows greater interactivity among groups and provides a better overall experience for the student presenting as well as the group receiving the information.

Future Plans for the Modules

With continuing improvement in bandwidth transmission rates, a web-based version of Orthodontic Diagnosis may be produced to allow even larger distribution. McGill University and Dr. Retrouvey are also working on an extension of the project by designing a virtual patient database using the same conceptual approach as used in the multimedia modules. This will contribute to the creation of a virtual environment in which a large number of relevant orthodontic cases can be presented. Learners will have the opportunity to study, practise and be evaluated on their knowledge of orthodontic diagnosis. This development, which is supported by the Canadian Association of Orthodontists' foundation and McGill University, will enable orthodontic teachers to standardize their instructional material and ensure that all future Canadian dentists are trained in a similar fashion.

Conclusion

After 5 years of use, the Orthodontic Diagnosis program has been well received by students and seems to offer an interactive and successful method for learning the complexities of this discipline. Course evaluations consistently provide positive feedback regarding the user friendliness of the program

Sound instructional design provides a framework for future projects that will allow teachers to further improve instruction using a web-based environment. Students will have access to material that is always up to date and can be adapted to their own needs. Interactivity will engage students in their own learning experience by providing an authentic environment for practice and feedback to improve their clinical skills. Our next step with this program is to update it and make it available on the web to reach a larger audience.

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References

1. Collins MP, Berge ZL. Using instructional design for faculty development in a post-secondary technology-enhanced environment. *Educ Technol* 2003; 43(6):21–7.

2. Chickering AW, Ehrmann SC. Implementing the seven principles: technology as lever. *AAHE Bull* 1997; October:3–6. Available: www.tltgroup.org/programs/seven.html (accessed 2008 July 12).

3. Graham C, Cagiltay K, Lim B, Craner J, Duffy T. Seven principles of effective teaching: a practical lens for evaluating online courses. *Technol Source* 2001; March/April. Available: sln.suny.edu/sln/public/original.nsf/0/b495223246cabd6b85256a090058ab98 (accessed 2008 July 12).

4. Laurillard DM. Rethinking university teaching: a framework for the effective use of educational technology. 2nd ed. London: RoutledgeFalmer; 2002.

5. Ehrmann S. Asking the right question: what does research tell us about technology and higher learning? *Change* 1995; 27(2):20–7.

6. McKeachie WJ. Teaching tips: strategies, research and theory for college and university teachers. 10th ed. Boston: Houghton Mifflin; 1999.

7. Gandell T, Weston C, Finkelstein A, Winer L. Appropriate use of the web in teaching higher education. In: Mann BL, editor. Perspectives in web course management. Toronto: Canadian Scholars' Press; 2000: p. 61–8.

8. Weston C, Gandell T, McAlpine L, Finkelstein A. Designing instruction for the context of online learning. *Internet Higher Educ* 1999; 2(1):35–44.

9. Molenda M. In search of the elusive ADDIE model. *Perform Improv* 2003; 42(5). Available: www.indiana.edu/~molpage/In%20Search%20of%20Elusive%20ADDIE.pdf (accessed 2008 July 12).

10. Heinze A, Procter C. Online communication and information technology education. *J Inf Technol Educ* 2006; 5:235–49. Available: jite.org/documents/Vol5/v5p235-249Heinze156.pdf (accessed 2008 July 12).