Scaling-up Undergraduate Medical Education: Enabling Virtual Mobility by Online Elective Courses

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Aim To evaluate online elective courses at Croatian medical schools with respect to the virtual mobility of national teachers and students and virtual team collaboration.

Methods A student-centered virtual learning environment developed within the framework of the European Union Tempus Programme allowed national educational services to design and deliver online undergraduate elective courses. Three online elective courses were created for second-year medical students of four Croatian medical schools by using Moodle, an open-source learning management system. The courses supported problem-, project-, and decision-based learning and required students to work in small collaborative teams using problem-solving and decision-making activities. The purpose was to foster teamwork and produce better outcomes than those potentially achieved through individual work. We evaluated the results of these online courses on the basis of the course test results and students' evaluation questionnaires.

Results Of 68 students enrolled in all e-courses, 97% (n = 66) successfully passed the final exam. An anonymous online questionnaire was filled out by 83% (n = 50) of the students. The majority expressed their satisfaction with the online electives, mostly because they had more contact with tutors and peers (n = 47), better possibilities of self-assessment (n = 38), more flexible learning (n = 33), better access to learning materials (n = 32), faster and easier information retrieval (n = 31), and better quality of communication with tutors and peers (n = 28). Although 38 of 50 students claimed that participating in e-courses was more demanding than participating in traditional electives, more than half (n = 27) would enroll in an e-course again.

Conclusion Elective e-courses may be a successful model of how faculty and students at higher education institutions can collaborate and integrate e-learning into their current curricula.

Scaling-up of undergraduate medical education can be defined as a process of reaching a large number of medical students over a wide geographical area (1). It may be achieved by introducing effective online-based learning programs and enabling virtual mobility of both students and teachers.

Due to today's technology, educational opportunities are no longer location-dependent, but allow for collaboration among students and teachers in different regions, bringing more quality benefits to more students more rapidly, more fairly, and more tenably (1). Online-based learning is especially advantageous for those not able to participate in physical exchange programs, because it allows them to benefit educationally and culturally from the experience offered by other universities (2). In addition, virtual mobility can play an important role in reaching the Bologna objectives in an effective and innovative way, although distance education is not currently incorporated in the Bologna process (3).

Virtual mobility can motivate institutions to readjust and develop further their pedagogical models, because changes in learning tools and content delivery methods call for the introduction of new pedagogical and didactic models, such as guided self-study, problem-based learning, and project-based learning. Because the virtual web space allows the use of different intelligence modes – abstract, textual, visual, social, audial, and kinesthetic, the teachers are challenged to create new learning environments that use the potential of the web to exploit the natural ways in which humans learn. In short, virtual learning environments demand pedagogical shifts from the teachers controlling the teaching to the students controlling the learning (4). These modern pedagogical models based on socio-constructivist learning theory (5) perceive students as active participants who share ideas, use various information sources to solve problems, and collaborate to create synergy that results in the construction of new knowledge and produces better outcomes than those resulting from individual work. Virtual mobility courses designed in rich virtual learning environments are useful because they can help students develop team collaboration skills. The capacity for and understanding of teamwork, along with critical thinking, adaptability, and self-evaluation, is a generic skill that should be fostered by university education (6). Consequently, to fit the changing educational models and make the learning experience meaningful to net-generation students (7), medical teachers need to re-evaluate and revise their undergraduate medical curricula and take account of modern educational theory and research, in addition to making use of modern technologies where evidence shows that these are effective (8).

Although mobility and collaboration of students and teachers are at the core of the Bologna process (3) and ever more important for European education policy makers, physical mobility of students is still rather marginal in Europe (2) and even more so in relatively disadvantaged transition countries like Croatia (9). During the past three years, all four Croatian medical schools have collaborated on harmonization of their teaching programs to allow for mutual accreditation and mobility of students. Croatian medical schools have discipline-based curricula and mostly use traditional teaching methods without much vertical or horizontal integration (10).

There is little evidence on online learning shared among students of medical schools in different regions. This article presents a model of collaboration among higher education institutions incorporating information communication technologies (ICT) in their current working practice and deploying online learning across the country in a unifying way. The virtual mobility pilot project intend-

ed for Croatian medical students and teachers was developed and implemented as part of the Standardization in Teaching of Medicine project funded within the framework of the Trans-European mobility scheme for university studies (Tempus) program (11).

Participants and methods

Learning environment

To set up the Interactive Medical Education Centre (InterMeCo) as a rich student-centered virtual learning environment (12), the Moodle learning management system was used. Moodle is an open source software package offering sound pedagogical principles to help educators create effective online learning communities (13). It is a user-friendly application and one of the most popular open source learning management systems in the academic community (currently, there are 36797 registered Moodle sites from 199 countries) (13). Moodle enables the delivery of instructional resources, communication, and collaboration. It simplifies administrative tasks, tracks students' achievement, and maximizes meaningful and reflective interactions, while providing a variety of opportunities for individual study and collaborative teamwork as well as feedback.

The Lightweight Directory Access Protocol (LDAP; *http://www.openldap.org/)* authentication was used to access InterMeCo. LDAP is an open standard for directory services on the Internet, enabling anyone to locate organizations, individuals, and other resources. The courses are password-protected and free anonymous login of "guests" is not allowed. However, all interested parties are welcome to ask for a personalized login with guest permissions. The reasons for password protection are the following: 1) to control the number of students and consequent faculty workload, as well as the quality of interaction between students and tutors; 2) to protect students' confidentiality and students' and tutors' original work; and 3) to maintain a certain level of discipline (for persons who misuse the online environment). Students may access their course a few days in advance to become familiar with the technology and meet their e-classmates.

The interdisciplinary Tempus project team of 18 professionals (university teachers, researchers, and instructional designers from medical schools participating in the project) spent approximately 10 months developing the InterMeCo learning environment and creating online elective courses intended for all Croatian medical students. The two interdisciplinary courses, "My first scientific paper" and "ABC of management for medical students," were completely new, whereas "Acid-base balance in humans" was adapted from an already existing elective course and enriched with new interactive applications. Two courses were offered in a hybrid setting ("My first scientific paper" and "Acid-base balance in humans") and one was delivered entirely online ("ABC of management for medical students"). Each online course, divided into 5-10 modules, lasted one week and was credited with 1.5 European Credit Transfer System points (14). The course materials were presented through a series of web pages or text documents, illustrated with original drawings, photographic images, and animations. For each topic, there were notes, objectives, assignments, self-assessment quizzes, educational games (eg, interactive crossword puzzles or scrambled words), and links to outside web resources.

Students and tutors

A total of 68-second-year medical students from all four Croatian medical schools (32 from Zagreb, 17 from Split, 16 from Osijek, and 3 from Rijeka) volunteered to take these courses. The number of students per e-course varied from 16 students participating in "My

first scientific paper" to 23 taking "Acid-base balance in humans" to 29 participating in "ABC of management for medical students." There were no dropouts.

Each course was coached online by a main tutor and a local tutor in each medical school; teaching assistants were assigned to help students with their field research and practice. Overall, 3 online tutors, 7 local tutors, and 4 teaching assistants took part in the project. Online teaching was administratively treated equally as teaching of other traditional elective courses. The e-course authors were awarded 60 credit-hours each.

All Croatian medical schools provided computer facilities with unrestricted Internet access for classroom use and general student access. Students did not have any problems or complaints about the e-learning platform.

Instructional model

Computer-mediated teamwork is an instructional strategy that combines online technologies and human interaction (15). The courses were designed to be student-centered and to support problem-, project-, and decision-based learning. They required students to work in small collaborative teams using problem-solving and decision-making approach in order to create synergy and produce better outcomes than those potentially achieved by individual work. Collaborative learning is defined as a style of teaching and learning where students work in teams toward a common goal (15). Students become actively involved in constructing knowledge by applying concepts to problems and formulating ideas into words. This means that learning is not only active, but also interactive (16).

At the start of each class, students from different medical schools were assigned to virtual teams of 4-5 members. They interacted using various communication tools provided by the InterMeCo virtual learning environment (e-mail, collaborative web forums, synchronous text chat, instant messaging, and wiki), as well as by tools outside the virtual learning environment, like Skype free phone and free video calls (*http://www.skype.com*) and Google Docs (free web-based word processor and spreadsheet, which allow online sharing and collaboration; *http://docs.google.com/*).

The courses were a blend of asynchronous and live virtual classrooms. Some segments of the material were self-paced, while others were taught in a live virtual classroom that allowed running a training program in real time with the tutors and students being online at the same time. A unique aspect of the online courses was the requirement that all students participate in a 90-minute synchronous chat class session on a daily basis. They used chat sessions to ask questions, respond to the tutor's questions, and participate in discussions. Separate chat rooms were also used by the students for teamwork during breakout sessions. Chat messages were all archived for later use by the students and for research purposes. The instructor facilitated the discussion and encouraged the students to ask questions, provide comments, and discuss issues that would improve their understanding of the topic.

Learning effectiveness and satisfaction

Learning effectiveness was measured in terms of student learning outcomes and satisfaction. Learning outcomes assessment was based on the student scores on the final tests. The number of questions in the final online tests for the three courses was 12, 36, and 47, respectively. The minimum pass level for all three tests was 55% of correct answers. The final exam was proctored by the instructor to verify the identity of each student. The tests were timed and automatically graded by the Moodle system.

In the e-course "Acid-base balance in humans," the students took a pre-test. The students' knowledge gain was determined by the difference between their pre-test and final test scores.

An online questionnaire of 36 questions (web extra material) was used to collect data on course evaluation, student's self-evaluation, and students' attitude toward and overall satisfaction with the online course. To ensure anonymity, the survey was performed outside the InterMeCo environment. The questionnaire consisted of a 5-point Likert-type scale (1 – strongly disagree, 2 – disagree, 3 – do not have any opinion, 4 – agree, 5 – strongly agree) and multiple-choice questions (Table 1). The online questionnaire was created by eListen software (eListen, Scantron Corporation, CA, USA).

Statistical analysis

The test for difference between proportions for small dependent samples was used to determine the students' knowledge gain. Data from the students' web session variables were summarized using descriptive statistics (means and standard deviation). Statistical computations were performed with *Microsoft® Excel 2000*, and the level of significance was set at $P<0.05$.

Results

Online tests

The overall pass rate of 68 enrolled students on final online tests for all three e-courses was 97% (n = 66). Two courses had a 100% pass rate; on average, students correctly answered 79% ("My first scientific paper") and 89% ("ABC of management for medical students") of all questions on the final test. In the third course ("Acid-base balance in humans"), 21 of 23 students passed the final exam and answered on average 70% of questions correctly. Given that the percentage of correct answers on the pre-test in "Acid-base balance in humans" was 40%, the students' knowledge gain was significant ($t = 7.72$; $P<0.001$). The two students who failed the first exam had the second opportunity to sit for the examination in the following exam term.

Electronic administration data

Student usage of the site was generally high, but varied widely between individual students.

Table 1. Questions from the online questionnaire related to students' attitudes toward e-courses and e-learning (questions that were too specific or had scattered results were excluded)*

Question and answers	Percentage of students (n = 50)
Compared with traditional learning, taking elective courses in an online context means:	strongly agree and agree
27. and 30. More contacts with tutors and colleagues†	94
36. Teachers are facilitators and coordinators (rather than commanders or observers)	80
7. Better possibility of self-assessment and feedback	76
22. More demanding work	76
12. Flexible learning (anywhere)	66
1. Better access to learning materials	64
6. Faster and easier information retrieval	62
9. Better quality of communication with tutors	56
13. Flexible learning (anytime)	54
17. Experience I would like to repeat with other courses	54
8. Better preparation for the final exam	46
5. More difficult understanding of course materials	42
2. Easier learning	40
11. Lack of "human" aspect of teaching (spontaneous comments, humor, body language)	34
16. Unequal position in comparison to students who own personal computers	20
15. Problems because of insufficient number of institutional computers	16
14. Problems because of insufficient information and computer technology knowledge	12
18. Total failure of the course	10

*The complete questionnaire with detailed student responses is available as web-extra material.
†The number refers to the question number in the online questionnaire.

During the 5 days of course duration, the median number of students' logs was 530 (range, 77 to 1705). In the same period, the mean access of the tutors was 1249 ± 808.

The most frequently visited pages were communication tools, such as chats and forums, while support pages were poorly accessed. On average, 179 ± 65 chat logs were registered per student.

Online questionnaire

Of 68 students, 50 (74%) filled out the anonymous online questionnaire. The majority expressed their satisfaction with the online electives, mostly because of more contact with tutors and peers (n = 47), better possibilities of self-assessment (n = 38), more flexible learning (n = 33), better access to learning material (n = 32), faster and easier information retrieval (n = 31), and better quality of communication with tutors and peers (n = 28). Although 38 of 50 students stated that participating in e-courses was more demanding than participating in traditional electives, more than half (n = 27) would enroll in an e-course again (Table 1).

The quality of instruction was rated on a 1 to 5 scale (1 – worst, 5 – best). The possibility of self-assessment and availability of immediate feedback was assessed as very good (3.8 ± 1.1). Regarding the communication possibilities with the tutor, 47 of 50 students contacted their tutors and peers directly more than once (Table 1, question 27). The main and local tutors' overall performance was rated as very good (4.3 ± 1.0 and 4.1 ± 1.2, respectively), and the overall quality of the courses was rated above average (3.6 ± 1.2).

Discussion

The aim of this pilot project was to assess the benefits of virtual mobility of students and teachers. There is still little evidence about online collaborative learning among students who attend different medical schools. This approach is probably practical in cases where students share the same language and have a common curriculum (17). In an increasingly globalized society, many learners seem to appreciate the advantages and opportunity of working collaboratively and closely with colleagues from other institutions and having access to the course instructors and experts from other universities (18). There are advantages not only in terms of learning from each other, but also in terms of acquiring essential teamwork and lifelong learning skills (19). Appropriately used technology has the potential to change the way teachers present material and access resources, change the style and amount of their interactions, facilitate the development of learning communities, facilitate the way teachers address individual differences, and increase the varieties of digital media used (20). Moreover, the flexible nature of virtual mobility approach makes it relatively easy to fit in with the existing modes of curricular organization as an alternative to costly physical mobility programs. Thus, developing joint virtual mobility programs allows cost sharing and risk reduction. The largest cost is the initial development of technology-based training. Because this cost is the same regardless of the number of students, technology-based training may be too expensive if the audience is small. In the long run and for large number of students (from several medical schools), e-learning has a cost-saving potential. However, for integrating virtual mobility in the mainstream medical education and making it sustainable in the long term, all stakeholders (teaching staff, students, management in institutions, and policy makers) should recognize its advantages.

Although our previous experience shows that e-learning positively influences student learning outcomes (21), there is no clear evi-

dence that online learning is more effective than traditional teaching (22,23). We agree that learning through technology is neither better nor worse than traditional face-to-face education; it is just different (24). Therefore, the main questions for the teachers to answer would be in what contexts and with what purpose the technologies should be best used.

In terms of education, we see benefits for the students not only through their learning of the course material, but also through their learning of new technologies that allow them to have better communication with tutors and colleagues, flexible anywhere/anytime learning, better access to learning materials, and faster and easier information retrieval. In fact, medical students have to have many skills to study efficiently and for them, the use of information technology and the Internet becomes increasingly important. The World Federation for Medical Education (25) advocates the integration of information and communication technology into the medical curriculum in order to enhance quality of care and enable continuous knowledge updating. However, despite the large amount of literature favoring online collaborative learning (15), teams often do not work well (26). There is also evidence that collaborative learning has its disadvantages and that virtual teams are less effective and more prone to misunderstanding than face-to-face teams because of less interaction between the team members (27,28). Our virtual teams experienced some minor collaboration problems, although the overall interaction was successful. There were minor conflicts between students from different schools, mainly because some team members appeared to contribute very little to team activities and the creation of deliverables. The main reason for this was that academic calendars of the participating medical schools were not well harmonized. Consequently, some students had overlapping obligations (exams) and, therefore, not enough time to participate in online team collaboration. To avoid this problem in future, more attention should be given to adjusting the time-tables of the participating institutions.

It is well-known that instructional methods that actively engage learners improve learning outcomes (29). All our students were active and interactive participants, which is usually very difficult to achieve in the traditional face-to-face teaching setting. However, our students were self-selected and, although they had earlier experience with traditional elective courses, it was their first experience with online electives and virtual mobility. Thus, it is possible that their enthusiastic activity could have been influenced by the effect of "the first time experience." In addition, the online survey offered the possibility for students to write freely their comments and suggestions. They mostly appreciated the time/place flexibility of online learning, the availability of the tutors, and the immediate feedback. However, some students expressed their general dissatisfaction with teamwork, probably because they had never experienced it before. Educators who implement online collaboration should be prepared for opposition from students taking such a course for the first time. This opposition occurs because the majority of the students are used to traditional teaching methods in which their teachers tell them everything they need to know (30).

Despite limitations and minor team-work problems, the overall learning outcomes and satisfaction of our students show that the virtual mobility pilot project among medical schools could be used as a successful model of how teachers, researchers, and students from different higher education institutions can collaborate, incorporate e-learning into their current working practice, and deploy online learning across the nation in a unifying way.

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