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Lessons Learned: Implementation of a Nationwide Innovative E-Learning Module for Health Enabling Technologies

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Abstract. E-learning enables students to participate in online courses across universities. As a part of the HiGHmed joint teaching and training program, we developed an e-learning module entitled *Health Enabling Technologies and Data* based on the Gilly Salmon 5 stage model didactic concept. This course was implemented at a German Technical University in the winter semester 2019/20 and evaluated by the students after completion. Student evaluation indicates good teaching presence but improvable social presence. From the perspective of the lecturers, we have learned that interactivity should be enhanced to improve the students' engagement, and incentives shall be established to foster students' active participation. Therefore, we will revise the course for the next term by (i) web conferences, (ii) assessment of interactivity, and (iii) clear "take-home" messages.

Keywords. e-learning, health enabling technologies, lessons learned

1. Introduction

Educating students is a key responsibility of universities [1]. E-learning allows students to learn independently of time and place [2]. In light of the current situation regarding the coronavirus disease (COVID-19) pandemic and the restrictions on contact, online-based courses may allow to bridge this crisis.

To guarantee the qualified handling of data in health care and research by future researchers, the implementation of new e-learning modules is on demand [3]. The HiGHmed consortium brings together outstanding competencies in teaching and training in medical informatics and is part of the medical informatics initiative in Germany. In this context, we developed an e-learning module entitled *Health Enabling Technologies and Data* and implemented it in the winter semester 2019/20 at the TU Braunschweig [4]. Health enabling technologies (HET) can continuously monitor vital parameters, which supports physicians in detecting diseases. HET worn on a human body to measure cardiac activity, generate data that may be superimposed by artifacts, such as movement artifacts and recording gaps. Hence, HET imposes challenges in signal processing as well as semantic integration of this data in electronic health records which need to be addressed in the curricula of medical informatics students.

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Therefore, we implemented this e-learning course to cover HET data management from a comprehensive perspective, starting with data generation, followed by its recording, storing, and ending with its analysis. In this work, we want to share our experience and the lessons learned from the lecturers' perspective when implementing this e-learning module. Additionally, we analyze the students' feedback obtained using evaluation sheets from the first roll-out of our online module.

2. Method

2.1. Didactic Concept

An appropriate didactic concept builds the foundation of an online course. The concept has to fulfill four criteria: (i) *Implementable* with existing learn management systems (LMS) available at all academic partners, e.g. ILIAS, Moodle, and Stud.IP; (ii) *Reproducible* structure, which ensures the comparability of courses and enables a consistent evaluation; (iii) *Enable* various learning outcomes for different target groups; (iv) *Adaptable* for academic, applied, or clinical practice for each target group.

As the didactic concept of the proposed e-learning course, we chose on the Gilly Salmon 5 stage model: (1) access and motivation, (2) online socialization, (3) information exchange, (4) knowledge construction and (5) development fulfill the addressed criteria [5]. We implemented this model as follows: All teaching material is online accessible. An e-moderator sets tasks, provide teaching material, clarify open questions of students, sensitizes for learning difficulties, and moderates the learning process [6]. During the course, the learners have to solve online interactive tasks, i.e., e-tivities [7]. The e-tivities are structured as purpose, task, and response [7]. To fit the four criteria given at the beginning of this chapter, this concept can be implemented in different LMS using open-source software such as ILIAS, Moodle, or Stud.IP and the concept also has a reproducible structure. This enables a comparative evaluation of all courses and ensures a certain level of quality. Furthermore, it is possible to allow different learning outcomes for the different target groups and to address various levels of practice. Because everyone can learn at their own pace and has the opportunity to deepen certain topics of particular interest.

2.2. Course Structure

The course has four main subject areas (i) introduction, (ii) processing of HET signals, (iii) data analytics and (iv) data integration and is structured in eleven chapters: (1) HET environment, (2) Sensors for HET environment, (3) Sensor integration, (4) Data recorded in HET environments, (5) Quality of recorded data, (6) Signal enhancement, (7) Feature-based signal analysis, (8) Signal analysis using deep learning, (9) Interoperability, (10) Semantic interoperability standards, and (11) HiGHmed use case cardiology and ethics.

To implement this course we used the Stud.IP system with the plugin Courseware. The students tested the plugin before the course started and were offered introductory documents for using it. 59 teaching videos are produced with the software Camtasia by qualified teachers as well as a domain expert. Each video has a minimum length of 5 minutes and a maximum length of 15 minutes. The average duration of all videos is 12.1 minutes and the total length of all teaching videos is 11 hours 58 minutes. For each chapter, the students have to solve e-tivities. An example is shown in Figure 1.

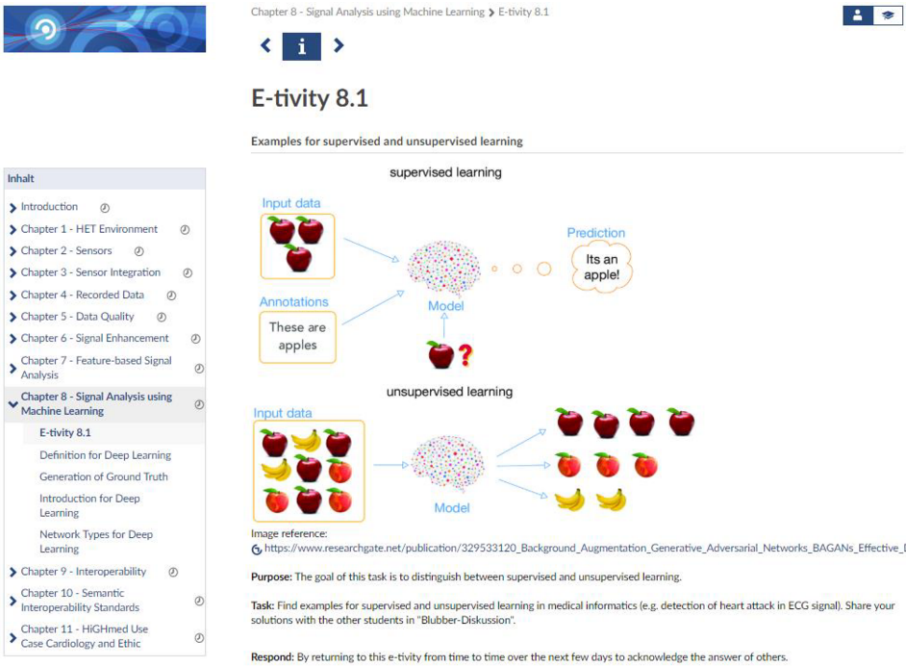

Figure 1. Screenshot of the course structure in Stud.IP with the plugin Courseware.

2.3. Evaluation

Eleven students successfully finished the module *Health Enabling Technologies and Data* and six of them filled out the evaluation sheet. The questions were designed based on the Community of Inquiry (CoI) method [8] and the roll-out was executed with the evaluation system EvaSys. Each student received a link with a TAN number by e-mail so that one student can only evaluate once. The evaluation used a 5-point Likert scale, where 5 indicates the best performance.

3. Results

The evaluation sheet contains questions regarding (1) quality of LMS, (2) teaching presence (3) social presence, and (4) cognitive presence. In the evaluation, the quality of the LMS used (Stud.IP) achieved the highest value with a mean value of 4.5 (Figure 2). Moreover, this category has the lowest standard deviation with 0.5.

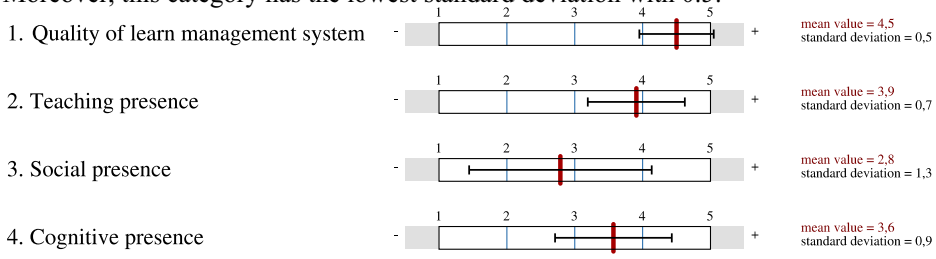

Figure 2. Boxplot of the global evaluation results regarding the four categories.

The teaching presence achieves a mean value of 3.9, which includes the communication of clear course objectives, quality of feedback, and motivation support of students. The lowest mean value is 2.8 for social presence. This category contains group cohesion. The cognitive presence has a mean value of 3.6 and covers the quality of discussions as well as knowledge development.

4. Discussion

This was our first e-learning course and no member of the teaching group moderated any online course before. We learned several remarkable lessons during the execution of the course and from our students' feedback. The small group of participants in the evaluation allows limited statements. However, the evaluation does indicate a direction. In the beginning, our focus was on the production of high-quality teaching videos and less on online socialization, resulting in relatively little student participation. The low interactivity has probably led to a weak sense of group belonging [7]. Besides, the incentive for the students was small, as they only received a grade for the written exam at the end of the course, and the participation in e-tivities was not included in the final grade. In the semester 2020/21, health care professionals and students from other nationwide academic partners will also participate in the online course, allowing us to revise the course and consider the following points: (1) each student will undergo a technical pretest before the course starts; (2) an incentive will be established for solving the e-tivities. Therefore, the solution of e-tivities, will be included in the final grade next to the final examination; (3) to increase the feeling of belonging to a group, every user will be asked to add a profile photo, we will also use web conferences between the e-moderator and the groups and online consultation hours; (4) the videos should include clearly defined learning objectives and "take-home" messages. The International Medical Informatics Association on education in biomedical and health informatics published recommendations to provide an appropriate level for teaching [9]. These recommendations are also transferable to e-learning.

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