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Visualization of Medical Wearable-Data Using SMART-on-FHIR – A Concept for an Interdisciplinary Complex Practical Course

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Abstract. For the success of digital applications, especially AI applications, it is essential that both developers and medical professionals are enabled to understand each other's perspective. For this reason, a new concept for an interdisciplinary complex practical course was developed for the master's program in computer science at a German university, based on online learning nuggets and a hackathon on site. The core of the concept is a real-world medical application task: extracting ECG patient data from a smartwatch to support primary care physicians in making decisions regarding an action. The concept was developed based on the so-called constructive alignment concept. An initial application of the concept showed that it was rated as very positive in terms of learning experience and working atmosphere.

Keywords. constructive alignment, blended learning, medical informatics, interdisciplinarity

1. Introduction

Digitalization comes with a lot of advantages for the health care sector. Given the technical possibilities, decisions can be supported by artificial intelligence (AI) algorithms that in some cases are able to predict or identify diseases faster or more accurately than physicians (e.g. [1]). However, AI application are not meant to be a replacement for medical staff but as an assistance tool [2] like MRTs for radiologists. In order to increase acceptance and trust regarding results that AI algorithms offer, it is necessary to achieve an interdisciplinary thinking [3]. That means, physicians need to be trained regarding technical aspects while technicians need to be trained in medical thinking. In this context, the paper aims to present a concept for an interdisciplinary course that is applicable on the master's degree level for computer scientists and future physicians at a German university.

2. Methods

The development of the concept should meet the following criteria: 1) The concept comprises technical aspects. 2) The content of the course is related to a medical question. 3) The technical and medical field are equally represented. 4) The course is designed for

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interdisciplinary cooperation between computer scientists and physicians. Taking these criteria into account, we have designed a course in a team of computer scientists, business mathematicians and psychologists (usability and technology acceptance specialists) with extensive experience in medicine. The design of the course followed the constructive alignment concept [4]. In this concept learning objectives are defined and communicated initially. Based on these, learning activities are identified that support the reach of the outcome. Finally, the examination methods are aligned to objectives and activities to ensure sufficiency. [5] The specific steps are described below.

2.1. Learning objectives

First, the learning objectives were identified. These included that the students:

1. Are able to describe the basic problems of medical data processing.
2. Know the basics of medical documentation systems.
3. Are able to transfer medical data into a representation suitable for medical personnel.
4. Are able to design a medical application considering the needs of medical staff.
5. Are able to extract health data from "mobile devices" and "wearables".
6. Are able to transfer medical data into the HL7® FHIR®[2] standard [6].
7. Know basics of extract-transform-load processes.
8. Are able to use FHIR® data using "SMART-on-FHIR" platform [7] to develop medical applications.

Here, 1st-4th are classified as medical and 5th-8th as technical aspects. In addition to these hard skills, students should also gain experience in soft skills such as communication, project management and leadership.

2.2. Teaching and learning methods

Based on the learning objectives, the teaching and learning methods were determined. The course is based on blended learning with online and in-person parts comprising 180 work hours in total (6 ECTS[3] - credits).

For the online parts and the communication with the students we used OPAL [8] - a German cross-university information technology platform for e-learning. This platform has several applications that support asynchronous communication via forum posts, email connections, and editable wiki pages. In addition, we used the functionality of the virtual classroom, which is mainly an open space for video calls.

Based on active research projects and discussions with medical personnel, the interdisciplinary team defined a task that requires both medical and technical knowledge. This task was designed for a period of one week (40 working hours straight).

Learning nuggets [9] for project planning, medical device regulation and technical aspects were created and literature related to the task was suggested. The learning materials were to be worked through independently by the students in free time allocation. The teachers were available for questions at any time. For the preparation phase one week (40 working hours) had been suggested.

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[2] HL7 FHIR - Fast Healthcare Interoperability Resources provided by Health Level Seven International

[3] ECTS - European Credit Transfer and Accumulation System

For the in-person part, we decided to follow the idea of a hackathon, where students had to plan the project themselves and monitor the progress. Student teams should form in a self-organized manner based on interest and ability; individuals with different skill sets should ideally work together. The teachers only had the role of partners with advanced knowledge and veto rights.

2.3. Examination method

Based on the learning methods the form of examination was selected. The exam consists of two main parts – a written documentation and an oral colloquium.

The written documentation comprises the project plan and the achieved project results. It is oriented to the documentation aspects that must be addressed according to the European Union Medical Device Regulation. The colloquium consists of a presentation (30 min) and a final discussion or Q&A session (15 min). The presentation is understood as a product pitch where students are expected to present their idea, methods and final solution including a live demonstration. The question round is led by an interdisciplinary review board with expertise in psychology, business mathematics, and computer science. In this round, any student can be asked any question regardless of their role in the project. The questions themselves mainly result from discussions, problems or experiences made during the hackathon.

The evaluation criteria for the examination performance as a whole were the quality of the implementation, the quality of the documentation, the final presentation (structure, content, adherence to time constraints), the answering of the questions and the appearance and use of language.

In order to continuously improve the course, an evaluation questionnaire was developed for the students, which included questions about the course schedule, the working atmosphere, the amount of therapy and practical exercises, and the assessment of the fulfillment of expectations.

3. Results

The overall result of the conceptualization (see chapter 2) was a course with four main parts (see Figure 1). In each part different materials are provided. Materials can be requested from the corresponding author.

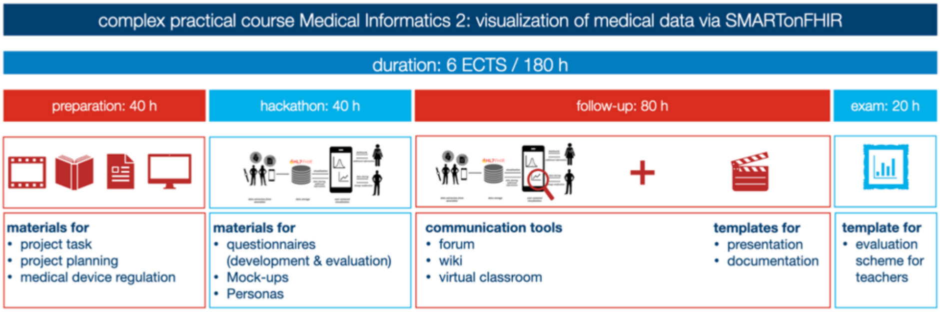

Figure 1: Course structure (red – online parts, blue – in-person parts; original illustration)

One essential aspect of the course is the initial task (see **Figure 2**) which equally includes medical and technical aspects. In this task a mobile application should be developed that can function as electronic patient records. The primary purpose of this patient record is to monitor (adult) patients in their home environment and to enable the family doctor to intervene in case of danger (e.g. by early identification of new (additional) cardiovascular diseases during treatment of another disease). For this purpose, the following sub-steps should be implemented:

1. It should be possible to **extract** ECG data from the Apple Watch and patient information (height, weight, and age) from the iPhone.
2. The extracted data should be stored as **FHIR® Resources**.
3. Based on this, a (SMART-on-FHIR) application should be designed in a user-centric way to visualize the data.
4. **Two groups** (physician, patient) should be considered.
5. Physicians should be able to **add data** (at least diagnoses) in the application.
6. Patients should be able to share their data with physicians and be informed about changes (e.g. by mail).

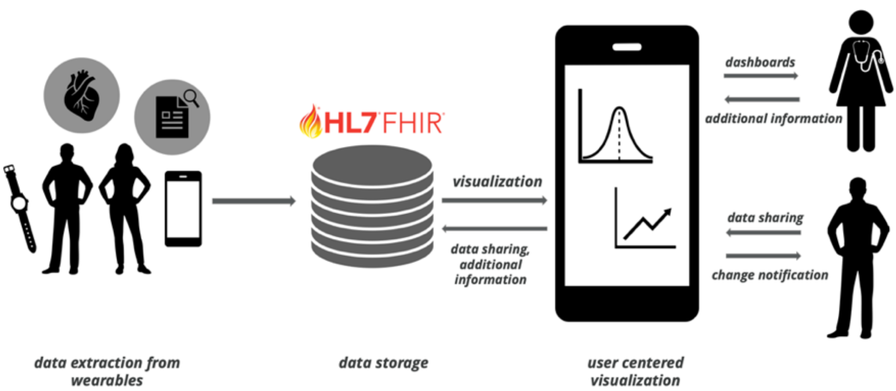

Figure 2: Graphical description of the project task (original illustration)

4. Discussion & Conclusion

The application of the course concept showed promising results. The students participated in the hackathon well prepared and formed a group very quickly. They worked cooperatively to solve the task and were receptive to the user-centered design. The feedback from the students showed a high level of understanding and motivation, especially with regard to medical issues and the need for interdisciplinary collaboration.

The evaluation of the course by the students showed that the working atmosphere, the balance of assistance and trial and error, the overall practical experience and the real-life application case were perceived as particularly positive.

The course is currently only creditable in the computer science master's program. Due to the limitations of the medical program, we are still working on integrating our course into this curriculum to achieve a higher degree of interdisciplinarity. However, due to the medical expertise present in our team, the course holds great promise for improving communication and collaboration between computer scientists and medical professionals.

Declarations

Conflict of Interest: The authors declare that there is no conflict of interest.

Author contributions: FB, IR concept development of the paper; FB, BS concept and teaching materials; CG, SH, IR technical expertise and evaluation of the course concept. MS responsible for the course as instructional supervisor and mentoring in course design. All authors contributed substantial ideas and participated in editing and revising of the manuscript. All authors approved the manuscript in the submitted version and take responsibility for the scientific integrity of the work.

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