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Data Literacy in Medical Education – An Expedition into the World of Medical Data

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Abstract. With the advancing digitization in medicine, digital medical data is playing an increasingly important role in health care and research, which is why data literacy must already be taught in medical education. To this end, a 28-hour online elective for medical students - following a constructivist approach – has been implemented. It teaches learners different aspects of data literacy for a critical collection and use of sensitive medical data. The assessment of the learners' reflections on the course topics shows, on the one hand, the importance of data literacy from learners' perspective and, on the other hand, the importance of taking an overarching and coherent view of medical data. In further curricular courses, such as medical ethics, and statistics, special themes are to be deepened in an application-oriented manner.

Keywords. data literacy, medical education, online learning, community of inquiry

1. Introduction

Advances in digitization in medicine are expected to have great potential for improving patient care and clinical research. Many current approaches (e. g., artificial intelligence, personalized medicine) rely on the collection, analysis, and application of enormous amounts of medical and health-related data (e. g., genomics, proteomics, health monitoring data), which are only made possible by digitization. The development of the corresponding software systems is usually in the responsibility of medical informatics and data scientists. However, also medical users of these systems, as well as medical decision makers, need basic data literacy to assess the utility and suitability of existing systems for their needs, as well as to communicate their requirements to data scientists and software developers. Ridsdale et al. identify data literacy as a key competency for the 21st century, defining it as "the ability to collect, manage, evaluate, and apply data, in a critical manner." [1] This critical handling is especially important in the area of medical research and patient care, where treatment decisions are based on particularly sensitive medical and health-related data. Against this background, it is important that the acquisition of data literacy is offered in medical education. The aim of the developed

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course is to provide medical students an overall framework in order to obtain a broader understanding of data-related aspects in different contexts.

This article gives an overview on the content of a data literacy course as an elective for medical students and presents the students' assessments of the topics of the course.

2. Methods

The developed 28 hours elective [2] is conducted over a period of five weeks with four online seminars of two hours each, as well as four hours per week of individual work time that can be freely scheduled.

Didactically, the design of the course follows the 5-phase HiGHmeducation didactical framework [3] and implements a constructivists approach where the learners form a community of inquiry [4]. Each learner works on a total of 14 tasks, divided in two to three tasks per week. The realization of the tasks is in line with Salmon's e-tivity concept [5], where every e-tivity includes a stimulating input to motivate learners to engage with the topic. Afterwards, each learner works individually on a task based on the input and other supplemental materials. This is followed by a moderated group work that involves saving the results in a wiki that can be edited by everyone of the learning group.

The structuring of the content is based on the five parts of data literacy according to Ridsdale et al. [1]. After an introduction to the conceptual framework, aspects of data collection, data evaluation, data management and data application are addressed in the e-tivitys. Additionally, educators from different research fields (e.g. physicians, medical informatics) bring their different perspectives and expertise on medical data into the course, fostering an interdisciplinary debate. Based on these concepts, learners should gain a deeper insight into the complexity of handling with (esp. medical) data.

In the final e-tivity, learners were asked to reflect on the content of the course on the one hand and the form of the course on the other. For this paper, only the reflection texts on the content are considered. They were subjected to a qualitative analysis in order to answer the following three questions: 1. How important do the learners consider the topic of data literacy? 2. How did the course change the learners' view of the use of data for research and health care? and 3. Which topics were of particular interest to the learners?

3. Results

3.1. Implementation of the data literacy course

Since winter term 2019/2020 the course "Digitization of Medicine - Data Literacy for Clinical Research and Health Care" has been conducted three times with a total of 26 learners. The course concept was first piloted in January 2019 with three learners prior to the Corona pandemic, originally designed as a blended learning course. In the summer terms 2020 and 2021, the course was then carried out entirely online. The content of the original three face-to-face seminars was transferred to four online seminars.

The topics of the course ranges from building a conceptual framework to considering data privacy and ethical issues in data application. Starting with basic definitions such as of data, metadata, but also Big Data, learners afterwards explore sources and collections of medical as well as health-related data and examine the types and structure of the

corresponding data. In addition, they deal with criteria for data quality and its assurance, learn about different types of artificial intelligence and their possibilities and limits in the field of medicine. Furthermore, data-related aspects of digital health applications are also addressed.

As an example, an e-tivity with the topic on "data management" will be described in more detail. The e-tivity starts with an introducing text and a short video about a fictional scientist questioning another scientist about his research data. Learners are asked to identify the problems addressed in the video regarding data management and sharing. In the next step, they shall work together on solutions to avoid the identified problems. In parallel to developing data literacy, learners also deepen their scientific work skills.

3.2. First qualitive assessment of learners' reflections

In total, 23 learners have written more than 7000 words in their reflections. The importance of data literacy from the learners' perspective was addressed. It is rated by the learners as "important", "useful", "essential" or "absolutely relevant" for work in clinical research and health care, but also for private life. In addition to recommending the course and wanting it to continue to be offered so that more learners can participate, four learners also expressed that all students should learn more about data literacy and that the content of the course should become an integral part of the curriculum.

In addition to acquiring a deeper insight into the topic of data and applying data, the learners also indicate that they want to be more sensitive in handling data themselves in the future. In this regard, aspects such as attention to data quality, data protection and interoperability are mentioned, but also the questioning of data collection, e. g. in order to be able to better classify data, is addressed.

The reflections roughly divide the particular interests of the learners into two groups. On the one hand, there is a strong interest in acquiring skills for data analysis using software tools (e. g. R, SPSS). Other learners are more interested in the aspects of data application, such as data protection, data ethics as well as approaches for an optimal integration of digital soft- and hardware solutions into everyday clinical life.

4. Discussion

Numerous activities – also in Germany – confirm the relevance of teaching data literacy in higher education [6,7,8]. In an increasingly technological world where the collection and use of digital data plays an increasingly important role, these topics must be included in education. However, Ridsdale et al. [1] already see this as a major challenge in the very tight schedules of degree programmes with densely packed content and suggest as a solution to integrate aspects of data literacy into other courses, such as courses dealing with statistical topics. However, the experience with the presented elective in medical education shows how important it is to take an overarching and coherent view of data literacy. Although the students mention individual subject areas that particularly interest them, at the same time they emphasise that only the elective has taught them how diverse the aspects are with regard to the collection, management, evaluation and application of data.

The reflections of the course did not take place anonymously, so that a certain influence of the learners can be assumed. However, due to the fact that the learners were

not supposed to reflect directly on the course, but rather on what they took away from the course for themselves, the influence should be low. The anonymous evaluations conducted after the course showed a very high level of satisfaction with the entire elective (13.1 points in summer term 2020, 14.2 in summer term 2021, on a scale between 0 (worst) and 15 (best)), which confirms the positive impressions from the reflections.

5. Conclusions

The described course provides learners with an overview of various aspects of data literacy. It aims to raise learners' general awareness of digital data and to reflect critically on its collection and use. In addition, by addressing the topic in breadth, learners should be enabled to thematically integrate in-depth aspects into the basic concept of data literacy. In further curricular courses, such as medical ethics, medical informatics, biometry, and statistics, special aspects are to be deepened in an application-oriented manner.

The reflections have shown that data literacy is also seen as an important part of education from the learners' point of view. Even though the learners state that they will be more sensitive in handling data in the future, this has to be shown in further research.

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