Chapter

A Salutogenic Approach for Collaboration in Health and Technology

Arild Berg, Safora Johansen, Anne Lund, Michael A. Riegler and Jorunn Marie Andersen

Abstract

Through collaboration, health services and health-promoting environments can be influenced by patients, health professionals, and stakeholders. Antonovsky's concept of salutogenesis includes the promotion of a sense of coherence, where the feeling of meaningfulness and people's ability to influence their own situation is central. These concepts were the units of analysis in this embedded case study, including an educational project analyzed in relation to relevant research projects. The educational project was the development of a new master course, "Interaction in health and technology," for students with different background in health-related education, including radiography, occupational therapy, biomedicine, biomedical laboratory science, artificial intelligence, and design. Through a qualitative content analysis, pitfalls and success criteria for collaboration in health and technology within a salutogenic theoretical framework were identified. These included user understanding of diagnostic value by artificial intelligence through visualization, user journeys for better health services, patient opinions about assistive technology, and developing understandable AI models. An interdisciplinary understanding of a sense of coherence as described in this study can strengthen collaboration in health and technology. The results of the current case study show also the potential for replication of the approach in different sites in various countries.

Keywords: occupational therapy, design, higher education, biomedicine, interdisciplinary collaboration, radiography, artificial intelligence, innovation

1. Introduction: new ways of understanding approaches to health and technologies

New technologies have affected our insight to health, including new ways of understanding approaches to health research systems [1]. The definition of health technology is according to World Health Organization (WHO) "the application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of life." [2]. As a subcategory assistive technology is defined by WHO as "the application of

organized knowledge and skills related to assistive products, including systems and services" [3]. Traditionally, in public health services, both principles and approaches have varied through time [4, 5]. From a philosophy of science perspective, both quantitative and qualitative methodological approaches have been used [6]. Participation and co-creation are needed to ensure that users, such as health professionals and patients, can take part in and influence new and improved solutions [7]. It is often an aim to develop methods in health where patients should be included in the validation of results before scaling up technology, for example, in advanced technology such as radiography [8]. From a technological perspective, there is a need for new thinking in education because new practices emerge with innovative technology [9]. An example is artificial intelligence, which is currently influencing higher education and the health sector. Critical reflections on new technologies and solutions are important to adapt to a new working life, where innovations are needed both locally and globally [10]. Due to general growth in societal complexity, the need for interdisciplinary education is growing [11] as well as knowledge about collaboration and co-creation [10]. Challenges in this matter are that professions change and therefore there is a need for critical studies about how to succeed in this matter. One way to achieve this is through a salutogenic approach, a concept introduced by Antonovsky [12]. Historically, this included the ability to use the resources available, as a sense of coherence. Today, Antonovsky's theory has influenced several societal practices, including both health and technology [13]. The use of Antonovskys theory and ontological position can be valuable in future health research as it integrates people in interaction with their environment as well as experiencing chaos and change as a normal state of life [13]. The salutogenic approach will contribute to flexible choices and possibilities for adopting to change for health professionals in a complex society.

2. Background: Changing positions between professions

Andrew Abbott developed a theory about the system of professions [14] concerning how expertise is changing in working life. He addressed how different professions have interacted through the ages and how new professions challenge previous professions as society evolves. He says that with an ecological perspective on professions, one can see professions in relation to how they grow through niches. Professions transform and leave a niche, opening up for new professions. He believes that professional history is characterized by struggles to occupy different niches. Abbott describes that there have been disciplines where certain professions have had precedence and that this has often been linked to the legal level, from which professional policymakers have asked for advice. Furthermore, he says that the professions together form a system so that they replace each other as society evolves and that the professions move, invading areas that appear to be more appropriate. Further, he describes that there are three levels in particular that this unfolds. The first level is in the workplace, the second level is in society; in the culture and general perception of society, and finally at the third level, it is in relation to laws and administrative rules [14].

There is such a change in positions between different professions, but also internally within the health systems, there are changes of professions, shown in a study about the coordination between health service professions [15]. The study demonstrates how the health service in Norway often is characterized by an increasing fragmentation of specialization, emphasizing the importance of developing

interactions and relationships between people that are characterized by equality, respectful mindset, and reciprocity knowledge. The study shows how four forms of collaboration can contribute to better health services, and these four are relational collaboration, coordinated task distribution, operationally closed collaboration, and fragmented task distribution. Relational cooperation is characterized by closeness and interconnection. Operationally closed cooperation is characterized by proximity and differentiation, where you work more separately. In a coordinated distribution of tasks, there is a long distance between the parties and participants cooperate from such distance with their own distinct tasks. Finally, fragmented task distribution is also characterized by both distance and differentiation, but here there are fewer meeting places both physically and digitally and little reciprocity knowledge. The conclusion of this study is that there are two types of interactions, ranging from fragmented task distribution to relational collaboration. The study shows that is not the conflict between understandings that is the main challenge for the interaction, but the lack of such a conflict. This is supported by literature on teamwork where stages of multidisciplinary team building in public health are characterized by Forming – Storming – Norming – Performing [16], where storming includes potential situations of conflict, such as discussions. Therefore, it can be important to not avoid conflicts but to strive for negotiations and discussions that highlight differences to achieve a real mutual understanding and reciprocity competence and respect for each other's work.

2.1 Co-innovation in higher education

In higher education, there is a need to address changes in each education to adapt to a changing working life, and bring about overarching innovations [17]. An example of such innovation potential is described in a study concerning a trans-disciplinary approach for co-innovation in social science and artificial intelligence [17]. It shows how there should be greater cooperation between international industrial cooperation and transnational university cooperation in larger sustainable ecosystems. This has synergies where, for example, machine learning and artificial intelligence can help make this synergy happen. The study refers to how the EU and China cooperation in technology and innovation has been tested. Their proposals for a transdisciplinary approach include both multiple disciplines and research fields, a transnational innovation ecosystem coupled with the civic engagement of universities. This is formed through international relations and various models of innovation where also institutional category and social network theory, social networks, analyses, and professional matching are important. Their long-term goal is to use artificial intelligence that can predict and propose potential and suitable universities and industry partners in international collaborations. This article is on a conceptual level, and the authors would like to discuss case studies with more practical examples.

2.2 The course: interaction in health and technology

Part of this objective is touched upon in this study, with a case study that includes a new university course in a new master's program in health and technology. The course name is "Interactions in health and technology." In order to achieve an inter-disciplinary approach to topics concerning health and technology, it is valuable for students to discover common ground. A patient journey could serve as a common

starting point with an aim for health and the will to do something good for the patient as a common context. Additionally, a health-promoting perspective in a wide sense could be used and applied in this chapter. The course was made for students with different backgrounds in health-related education, including radiography, occupational therapy, biomedicine, biomedical laboratory science, artificial intelligence, and design. International, national health and welfare schemes were used as a starting point for the education of professionals with new interdisciplinary competence that can solve growing welfare problems, including the aging population and new user groups, in the health sector. Because new technology is constantly being used in the health sector, being able to understand the technology and being able to talk to and collaborate with different professionals in the field is important. This applies both to relationships with users and patients, but also between professionals. The rapid technological development in the health sector requires better and new types of interaction between different actors to promote better and more efficient health services.

In the course, it was therefore necessary that students learn about technological development, system design, and service innovation. Both public and private actors can contribute with experiences and cases, but also other areas are relevant, such as specialist health services, municipal health services, the business sector, and other interest organizations. Students will through different cases explore how new technology contributes to sustainable solutions in health and care services and think and reflect on ethical challenges that arise when new technology is adopted. Interdisciplinary collaboration competence in the development and implementation of new technology in health and social services was emphasized in the course. Some of the things the student should know are, for example, to explain key concepts related to technological development, system design, and service innovation. Some skills they will learn in the course are to be able to discuss and evaluate established and new relevant methods in research and creative development work in health technology, but also to be able to discuss health technology as socially responsible innovation and research, RRI [18]. An important general competence in the course was that the student can reflect on and fit their own professional background, identity, and competence in an interdisciplinary context. By being able to reflect on user perspectives and professional identity from traditional and new perspectives, the student can identify opportunities for innovation processes within their own field of study and propose new solutions, work methods, services, or product-based innovation projects. In this way, the student can contribute to a user orientation of system design through critical thinking. Further, the student should use a suitable conceptual framework that promotes interdisciplinary interaction and contributes to interdisciplinary teamwork. A qualitative content analysis of the professional fields in the course was studied from a salutogenic perspective.

2.3 A salutogenic approach

A health-promoting way of thinking was developed by Antonovsky [12], where his principle of salutogenesis is about the path to health rather than thinking about the path to disease. Antonovsky studied concentration camp survivors after World War II and asked them what made them able to create a meaningful life even after horrific experiences. He found that those who fared best had created a connectedness in their lives, a sense of coherence. This has become a well-known concept

that has formed the basis for many holistic and overarching approaches in the field of health [5, 13].

A sense of coherence is including what is meaningful and understandable, and the opportunity to influence and change a situation or one's own life situation, such as an illness. The more a person is able to understand and fit in a suitable way into what they are supposed to do, the more it contributes to an increased degree of understanding. This is also about how you manage to create a meaningful whole in what you do, and how you feel or experience that the process connected to an illness is meaningful. The more individuals manage to handle a situation or their illness, it will strengthen the person's own health development and experience of being able to survive even a difficult situation.

The research question in this study is therefore how to collaborate in health technology with a salutogenic approach. The study will show some cases of what sense of coherence means in different professions, and how these different professions can collaborate.

3. Methods: embedded case study

In this case study, we want to unfold the concepts of salutogenesis related to a course that has been developed in the field of health and technology, where multidisciplinary groups are represented. This applies to physiotherapists, professionals in biomedicine, biomedical laboratory scientists, radiographers, artificial intelligence engineers, designers, and occupational therapists. These professions have traditions from both qualitative and quantitative research, so they are well suited to specifying what these concepts may mean in practice, because the examples may have transfer value to other interdisciplinary arenas for cooperation.

This case study [19] included literature studies, archival studies, artifacts, and participatory observation. We aimed for a deeper understanding of what salutogenesis can mean in interdisciplinary collaboration in health and technology through different work groups in an interdisciplinary team [20].

The scientific approach is based on a tradition in Hermeneutics or the way people understand the world and context they are situated in [21]. The philosopher Gadamer was concerned that in science as well as in everyday life, it was difficult to understand the world around you without taking with you the background you already have. You are characterized by your culture, upbringing, education, and also your field of study. Gadamer introduced the concept of preconceptions, fore meanings, which deals with our past experience as a prerequisite for our understanding, and also what he called the "horizon of understanding." Our horizon of understanding is a concept describing the limit of our understanding. He was concerned that we will never escape our own background and that we all have a limited understanding, but that it is possible to try to achieve a fusion of horizons of understanding, where one approaches in understanding each other. From a hermeneutic perspective, one can aim for a mutual understanding into a "fusion of horizons"; where in Gadamer's words the "old and new are always combining into something of living value, without either being explicitly foregrounded from the other" [21]. This view has been developed into post-phenomenology by Ihde, who recognized that people understand the world through technology, both advanced technology and less complex technology, such as glasses [22].

It is a goal to collaborate in health sciences, which increasingly collaborate with other disciplines, especially within technology. Mutual understanding and interest in other fields is a necessity. As technology becomes more and more advanced, the user-oriented approach from design professions stands for an important approach [23–25]. This user-oriented approach is also related to the individual's self-understanding, and empathy toward others understanding, as Antonovsky was concerned with, that you are part of a larger context, and that you have the opportunity to understand what you are a part of and how you can influence it. This is also a goal for people concerned with health and technology, both professionals, students, and patients.

Through such collaboration, it is conceivable that one should promote not only a pleasant and interdisciplinary tone, there are also ideas [15, 16] that want to promote the challenges and perhaps that collaborators should deliberately try to use different ways of understanding health, as a way to increase understanding of each other's differences and horizons of understanding, in line with Gadamer's ideas. In these studies [15, 16], conflict in group processes can be seen as a learning process that can strengthen interdisciplinary cooperation in the long term. To aim for, and to tolerate, seeing different points of view, creates a pedagogical challenge where students and professionals must both promote their own field of study, but also try to find a place in an interaction between different professionals, in a professional life that is constantly changing.

Through the study, we will identify different variations of sense of coherence, influence, and meaningfulness through an embedded case study with pattern matching [19]. The theoretical framework consists of subunits of analysis, the key components, connecting both success criteria with critical success factors as described in the Project Excellence Model [26]. The key components in this study have been connecting Antonovskys concepts, with pedagogical approaches. This included combining a sense of coherence, meaningfulness, and ability to influence a situation, with pedagogical approaches of Forming – Storming – Norming – Performing [16]. This was further discussed into problem-based learning, because this was suitable in such a dynamic context based on real problems in professional and working life, including diagnostic, treatment, and training, as well as health promotion both in the health care setting and in the community, where unique solutions must be developed every time [27].

3.1 Findings: exploring a sense of coherence through a multidisciplinary lens

We used articles and studies that are relevant to the case we have chosen: the topic sense of coherence in an interdisciplinary interaction course in health and technology touching upon user experience, diagnostics, treatment, healthcare services, communities, and research. In this study, we present articles that deal with interdisciplinarity and thus elaborate on the concept of sense of coherence from some selected areas; radiation therapy, physiotherapy, artificial intelligence, design, biomedicine, biomedical laboratory science, and occupational therapy. The purpose of this study is to show some examples from some chosen areas of professional expertise. This has an essential value for the chosen areas. Although they are specific, they represent a broad range of disciplines and demonstrate the variation of the fore understanding [21] of the same concept.

In the study, we thus see different examples of what a sense of coherence means in different disciplines in interaction in health technology, and we place special

emphasis on a sense of coherence, meaningfulness, and people's ability to influence sustainable development.

3.2 A radiography perspective

The first example we will refer to is from diagnostics where phantoms (**Figure 1**) and computer tomography (CT) technology are used [8]. CT is an X-ray machine using ionizing radiation for imaging. Ionizing radiation can be harmful to humans and should be held as low as possible. It is therefore not possible to test the impact of different CT parameters on image quality and patient dose by scanning patients in an experimental setting. Therefore, anthropomorphic phantoms are used by professionals and students to perform experimental scans in order to optimize the CT protocols used in routine CT examination of different human body parts. In this way, we avoid exposing human body parts to unnecessary radiation doses, which can be harmful and result in late side effects, such as radiation-induced cancer. The phantom used by an interdisciplinary group consisting of radiologists, physicists, radiographers, and students involved in the experiment will contribute to a close collaboration and understanding of a common goal, which in this case is to improve CT protocol optimization and improvement of patient treatment as a result of it. The phantom will also contribute to build up a feeling of mastering and coping, as well as establishment of an interaction between the team members. In other words, the phantom can be seen as an example of an interdisciplinary artifact (**Figure 2**), a boundary object [28] where different professionals can connect to understand a phenomenon with different backgrounds. Another example is using digital questionnaires, which can also be interdisciplinary where one looks at how one can use a digital tool to gain a deeper understanding of a topic. In this example, a questionnaire was used to explore the psychological impacts of COVID-19 on radiation technologists in Norway and Canada [29]. Boundary objects in this context can be an object such as a phantom or a method such as a digital questionnaire.

Figure 1.
Phantoms, detail.

Figure 2.
Phantom collection.

3.3 An occupational therapy perspective

Other examples of using this salutogenic approach are related to health promotion, both in healthcare settings and in communities. In occupational therapy, humans are seen as active beings, taking part in, and creating, meaningful activities resulting in improved health, quality of life, and well-being [30]. This can be seen as another way of understanding the sense of coherence raised by Antonovsky. The process of implementing technologies in people's lives is very complex and elaborates on interactions between actors in the field. In occupational therapy, studies have also been conducted by working user oriented and involving older adults in technology research and development. We present two examples where qualitative methods are applied.

Example 1 elaborates on that digital assistive technology has the potential to support older adults who depend upon community healthcare services. In the Assisted Living Project, we engaged older adults in co-creating knowledge about users' needs to guide the development of technological solutions [31]. In this study, user engagement was applied and aligns with the term occupational engagement [30] meaning to involve oneself or participate in occupations to create meaning. User engagement is an important strategy toward facilitating dialog, reflexivity, and the co-creation of knowledge, it can cast users in separate roles: as informants, as partners with researchers, and as independent investigators in relation to researchers as mentors [32]. To ensure the co-creation of knowledge about diverse occupations over a 3-year period, as well as considering older adults as experts on their own lives, we considered user engagement as a partnership arguing that co-creation entails engaging citizens

in actively taking part in innovation processes aimed at creating new and improved solutions for society [7]. The project demonstrates that older adults with impairments could meaningfully contribute with opinions on their needs. Applying a critical occupational perspective raised awareness regarding sociocultural assumptions about older adults in assisted living as frail and unable to participate, which may reinforce ageist and ableist stereotypes, as well as promote occupational injustice. This can also be related to that the participants created a sense of coherence and meaningfulness related to Antonovsky.

Example 2 is about involving older adults in technology research and development discussions through dialog cafés [33]. Citizen involvement is important for ensuring the relevance and quality of many research and innovation efforts. Literature shows that inadequate citizen involvement poses an obstacle during the research, development, and implementation of assistive technology. Previous studies have addressed the advantages and disadvantages of citizen engagement in health research and technology development, and there is concern about how to ensure valuable engagement to avoid situations where they do not have influence. Older adults are often excluded from being active partners in research projects. The overall objective of this project is to describe a case where dialog cafés were used as a method for involving assisted living residents in technology discussions, with the following research question: In what ways are dialog cafés useful for directing research and development and for engaging residents in assisted living facilities in assistive technology discussions? Six dialog cafés with assisted living residents (aged between 65 and 92) as participants were carried out over a period of 3 years (2016–2019). Reports that were written after each café by the group leaders and rapporteurs provide the material for the analyses in this paper.

This study demonstrates an example of facilitating user involvement where the participants felt useful by contributing to research and discussions on assistive technology and where this contribution in fact directed the research and development of the overall Assisted Living Project. This study also shows.

that dialog cafés enable older residents at an assisted living facility to contribute with opinions about their needs and perspectives on assistive technologies. This negates the view of older adults as too frail to participate and demonstrates the importance of including and collaborating with older adults in research. The findings can also be related to the fact that the participants created a sense of coherence and meaning by participating in the dialog cafés in line with the salutogenetic perspective by Antonovsky.

3.4 A perspective of artificial intelligence and biomedicine

A sense of coherence perspective can be applied to interdisciplinary work within biomedicine and artificial intelligence (AI), including the process of creating a collective understanding of the task at hand and interpreting the data resulting from the AI algorithms in a biological and patient-related context. The integration of AI in healthcare has the potential to revolutionize diagnostics, treatment, and patient care both in hospitals and in-home services for patients. However, interdisciplinary collaboration between medical professionals and AI experts is essential for the successful implementation of such technologies. The following examples show some challenges, highlighting the importance of interdisciplinary collaboration and suggesting potential pedagogical approaches.

The first example is using machine learning for predicting exposure to tacrolimus, an immunosuppressive drug, for individual dose adaptations in kidney-transplanted

patients [34]. In this study, machine learning techniques are employed to estimate tacrolimus exposure in kidney transplant recipients. The success of this approach relies on the collaboration between AI experts who design the algorithms and healthcare professionals who understand the clinical context and the pharmacokinetics of the drug. The challenges in the project were that different terminologies and methodologies used by AI experts and healthcare professionals may lead to misunderstandings. In an educational setting, balancing the technical aspects of AI and the clinical aspects of healthcare can be difficult.

The second example was a project about human reproduction, including embryo and sperm motility assessment using AI algorithms. Semen analysis is used as a part of male infertility assessment and the analysis protocols are standardized by the World Health Organization (WHO) [35]. This study used deep convolutional neural networks to predict sperm motility categories based on videos captured with a microscope-mounted camera [36]. Motility assessment of sperm is an important parameter in infertility investigations and the collaboration between AI experts and medical professionals was crucial in designing and evaluating the performance of these networks. For the AI-experts, it was important to understand some biological concepts and observe the samples together with the medical experts. This could be done using a discussion microscope (**Figure 3**) or looking at video clips. Another aspect is to investigate which part of the video was used by the AI model to ensure that a meaningful part of the image is analyzed by AI (**Figure 4**). This also leads potentially to a more visual understanding of what the algorithms actually are producing compared to showing numbers of difficult to interpret metrics.

Challenges in this project included the need for extensive training of the AI models to ensure accurate and reproducible results in both AI and a biological context. Furthermore, ensuring that AI models align with the standards and guidelines set in the WHO protocols. Relevant approaches for educational purposes would be integrating AI and biomedical concepts in the curriculum to expose students to the interdisciplinary nature of the field, utilizing case studies, simulations (**Figure 4**), or collaborative projects, to provide students with hands-on experience in interdisciplinary problem-solving.

Figure 3.
Discussion microscope.

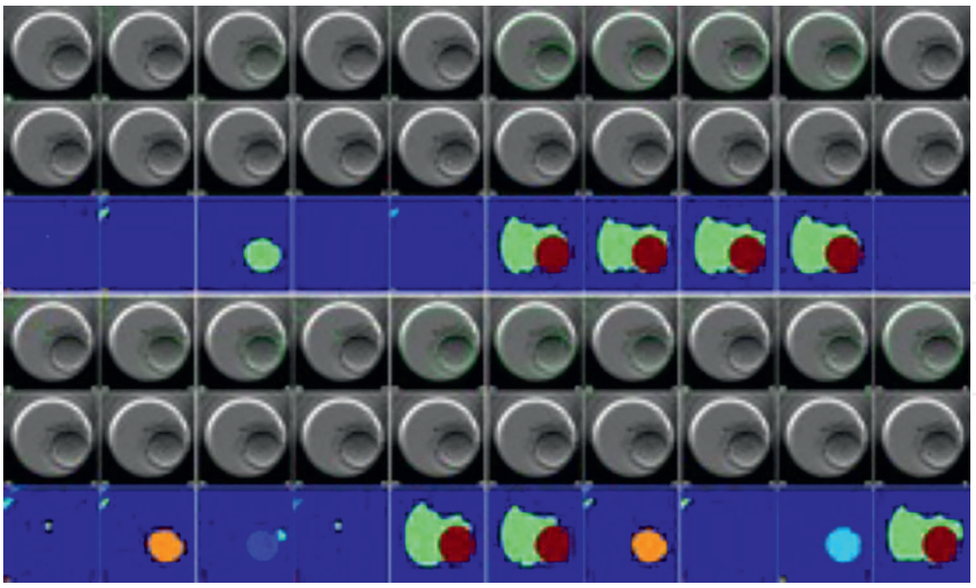

Figure 4.
Visualization of output from image analysis by an AI algorithm.

Interdisciplinary research and teaching in the context of AI, biomedicine and healthcare can be challenging due to differences in terminology, methodologies, and educational backgrounds. In addition, there is also a dramatic difference in the ethical aspects of different disciplines. Medical sciences have a culture of ethical behavior and commitment to the patient's best outcome, whereas in technology this is radically less developed. With the fact that algorithms become a part of our daily life, technologists also need to understand and develop a culture of ethical considerations focused on implications of the products they built. However, pedagogical approaches like Problem-Based Learning (PBL) [27] and the Forming-Storming-Norming-Performing stages of team building [16], can help students navigate these challenges and develop the interdisciplinary skills necessary for successful collaboration and a better cross-disciplinary understanding. By fostering a salutogenic approach, educators can promote a sense of coherence, and a deeper understanding in their students, empowering them to create innovative solutions in the ever-evolving fields of AI and healthcare.

3.5 A design perspective

An example of a user-oriented approach is the PACER research project on patient-centered engineering in rehabilitation. Here, four PhD students collaborated; a physiotherapist, an artificial intelligence engineer, a designer, and a medical technology engineer, studying what it takes to achieve good interaction between them [37]. Functional near-infrared spectroscopy (fNIRS) was designed as a cap where patients can wear to measure brain activity (**Figure 5**). Tests were done in a motion analysis laboratory (**Figure 6**). Technology and user experience were often not connected, and the aim of the project included new educational perspectives and participatory design related to patients' everyday activities. Some of the studies emphasized comprehensiveness and coherence, but other studies were more related to a monodisciplinary professional expertise that in many ways did not include the same understanding of coherence and context. For example, it was not always

Figure 5.
Cap for fNIRS.

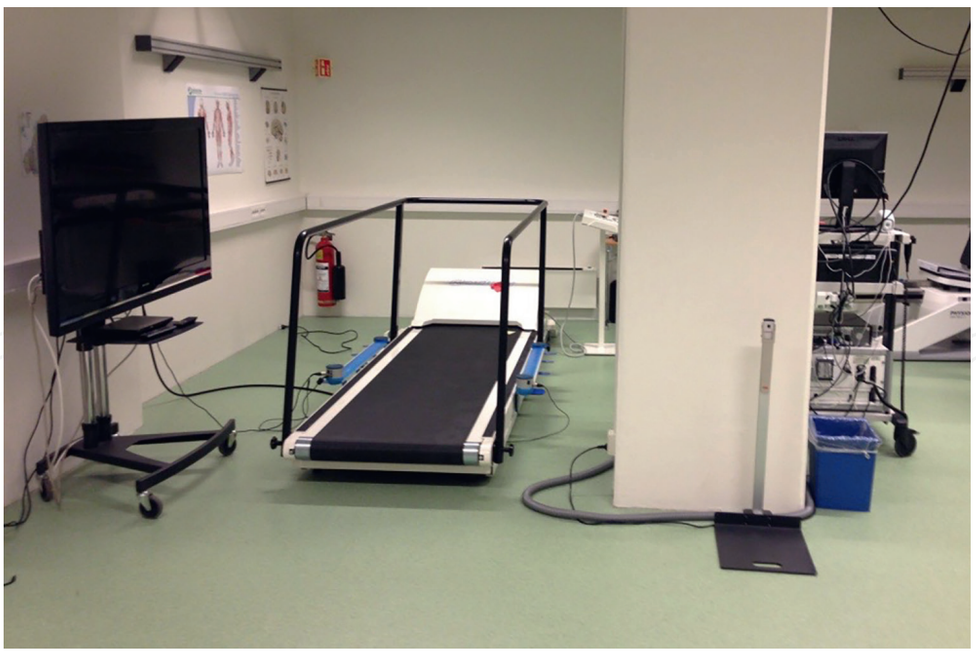

Figure 6.
Motion analysis laboratory.

relevant for someone who is developing logarithms in artificial intelligence to have a clear understanding of how the logarithms should be used in relation to a patient [38]. Nevertheless, this can be an appropriate way to put people together because they learn about different scientific traditions, different criteria for research, and different basic

principles and approaches in health, where understanding the world through technology is relevant as a postphenomenological perspective [22].

In the same way as testing a product in relation to a user [37], it is also possible to test a user-oriented approach of a patient in health services. For example, service design is an approach that is often used in the development of services by a commercial product. It can be how a customer experiences ordering a product, using the product, getting it repaired, and being able to return it for recycling. In the same way, a patient in relation to a health service can also be seen as a person who should experience both acknowledging their own illness, contacting the hospital, being led through a system, and receiving the right treatment. In all these stages, there are meetings between people, meetings between people and technology, and meetings between different professionals, where there is the possibility of improving the service or improving the product. The user experience is connected to the "front stage" activities, but the premises for the treatment often happen in the "back stage" activities, including technology and diagnosis processes. People often have a deep knowledge of their own situation and needs, which is why a user-oriented approach to service design has become increasingly common in health services [37, 38].

4. Discussion: success criteria and educational perspectives

In the discussion, we will look at different success criteria [26] for interdisciplinary collaboration in health and technology. In the model shown earlier, conflict can be a step on the way in the process of understanding each other. Possible conflicts in the examples we have shown are different understandings of what constitutes comprehensiveness and coherence, what are the responsibilities and roles of the various professionals in a larger context, and how they should influence their own situation and the situation of others in the process. In other words, it is not the case that the participants in the health and technology field should only accept the technologies that exist in the world today, but one should try to have critical reflections on how one can renew and improve both technology and ways of doing things, both the technological competence in interaction with the relational competence. Guiding process concepts in the pattern matching analysis [19] related to success criteria were salutogenic concepts related to Forming, Storming, Norming, and Performing (**Table 1**).

The identified concepts were related to the success criteria of project implementation [26], such as Forming, Storming, Norming, and Performing [16].

Forming the group should be related to formal requirements for health, environment, and security. Further, everyday activities can be a starting point using qualitative approaches to understand patient situations and promote health. In interdisciplinary collaboration, the participants understanding of diagnostic value can be strengthened through visualization and communication. A topic should be seen from various interdisciplinary perspectives. The group should understand the need for interdisciplinary collaboration.

In the storming, part possible divergent views should be enhanced, and these might be related to formalized procedures. Patient opinions about assistive technology can also lead to discussion. At this stage, the aim is to strengthen dialog and reflexivity to avoid misunderstandings.

In the norming stage, an aim is to have matured about the topic and process, and to learn about each other's areas. This requires an awareness regarding participants' own sociocultural assumptions [13]. Both dialog and reflexivity should be used for

Salutogenic concepts	Concepts for collaboration	Examples from cases
Sense of coherence	Collaboration with medical equipment	Phantom used by a interdisciplinary group
	Boundary objects	Digital questionnaire, phantoms
	Visual technology for common understanding,	Discussion microscope, images, and videos
	User understanding of diagnostic value by artificial intelligence through visualization	Visualizing the part of an image used by an AI algorithm
	Using advanced visualization technology for diagnosis	Computer Tomography (CT) technology for X-ray imaging
	Service design and user journey	Back-stage activities and front-stage activities, patient experiences in a rehabilitation process
	Globalization in health research and education	Collaboration between Canadian and Norwegian researchers
Meaning-fulness	Health, environment, and security	Using phantoms to minimize radiation exposure
	Contribution to improve diagnostics and patient treatment	Using AI for diagnostics
	Everyday activities and qualitative approaches to promote health	Taking part in and creating meaningful activities
	Deliver community health care services in line with users' needs through dialog and reflexivity	Dialog cafes with users
	Patient opinions about assistive technology	User experience with assistive technology
	awareness regarding sociocultural assumptions	Dialog cafes for engaging elderly people in technology development
	Treatment based on interdisciplinary collaboration	Predicting tacrolimus exposure in kidney transplanted patients using machine learning
Ability to influence a situation	Mastering and coping in practical health context	Use of phantoms
	Co-creation processes for innovation of assistive technology	Considering elderly people as experts of their own lives
	Developing understandable AI models that can be used in health practice	Interdisciplinary collaboration between medical professionals and AI experts is essential for the successful implementation
	Avoiding misunderstandings	Different terminologies and methodologies used by AI experts and healthcare professionals
	Co-designing new artifacts in health and technology	Construction of low-cost phantoms

Table 1.
Pattern matching analysis of salutogenic concepts in health and technology.

discussing, collaborating, and delivering healthcare services in line with users' needs. Health technology can be seen from interdisciplinary perspectives, like a boundary object [28] where several participants have an interest in a topic from different motivations. Visual technology can be used for common understanding, such as developing

understandable AI models that can be used in health practice. This can contribute to co-creation processes for technology innovation. Globalization in health research and education can contribute to a wider perspective [17] for the community to promote collaboration between universities and stakeholders from private and public organizations. Performing in health and technology can be related to interdisciplinary collaboration to improve diagnostics and patient treatment and promote health. Mastering and coping in practical health context can be achieved by learning to use advanced technology and by connecting technologically based health services with people's needs. Finally, experiences can contribute to co-designing new artifacts in health and technology.

4.1 Educational perspectives

The identified collaborative concepts can be related to educational perspectives for group work. In this study, it has relevance to problem-based learning [27], because collaboration with external partners from working life is recommended for higher education innovation systems [17].

In a course that brings together students from diverse backgrounds, it is essential to focus on the most important aspects that foster interdisciplinary understanding and collaboration. To ensure that all students have a good understanding of the core concepts, several aspects can be emphasized.

Common language and interdisciplinary communication are needed. This can develop a shared vocabulary and understanding of key terms and concepts from both the health and technology fields. Encouraging open communication and active listening can facilitate effective interdisciplinary dialog. Relevant applications and case studies can present examples of successful technology in healthcare. Students can discuss the challenges, methodologies, and interdisciplinary collaboration required in these cases, which will help students understand the practical relevance of their learning. Through problem-solving and critical thinking, students can be encouraged to apply their knowledge and skills to solve interdisciplinary problems. This can be done through group projects, case studies, or simulations, where students from diverse backgrounds collaborate and contribute their expertise to address healthcare challenges.

Students should have a good understanding of the most important core concepts and aspects by learning foundational concepts from several fields. Gradually they can build on these foundations with more complex topics, such as applying machine learning algorithms to predict patient outcomes or personalizing treatment plans. Peer learning and collaboration can be strengthened by organizing interdisciplinary group projects that address actual healthcare challenges, such as designing a mobile app for remote patient monitoring or creating a diagnostic tool for early disease detection. Students can be encouraged to share their expertise and learn from each other, fostering a collaborative environment. Providing constructive feedback will help students improve their understanding and address any misconceptions.

By focusing on these important aspects and employing effective pedagogical strategies, educators can create a learning environment that supports interdisciplinary understanding and collaboration, preparing students to contribute meaningfully to the rapidly evolving fields of technology in healthcare.

4.2 A salutogenic perspective in technology and health

A conclusive remark is that the salutogenic perspective applied in this study contributes to a broader and global theoretical framework based on existing literature

on salutogenic approaches in public health [5] that can include concepts such as to collaborate with medical equipment, including user journey for designing better health services, and to deliver community health care services in line with users' needs through dialog and reflexivity. Further concepts include co-designing new artifacts in health and technology, stimulating mastering and coping in practical health contexts, and promoting globalization in health research and education.

The study contributes with a case study relevant to higher innovation systems globally [17]. An interdisciplinary understanding of a sense of coherence as described in this study can strengthen the collaboration between professionals and students in health and technology. The results of the current case study show also the potential for replication of the approach in different sites in various countries.

Author details

Arild Berg[1*], Safora Johansen[1], Anne Lund[1], Michael A. Riegler[2] and Jorunn Marie Andersen[1]

1 OsloMet – Oslo Metropolitan University, Oslo, Norway

2 OsloMet – Oslo Metropolitan University and SimulaMet, Oslo, Norway

*Address all correspondence to: arild.berg@oslomet.no

References

[1] Greenhalgh T, Jackson C, Shaw S, Janamian T. Achieving research impact through co-creation in community-based health services: Literature review and case study. Milbank Quarterly. 2016;**94**(2):392-429

[2] WHO. Medical devices. 2007. Available from: https://www.who.int/teams/health-product-policy-and-standards/assistive-and-medical-technology/medical-devices

[3] WHO. Assistive technology. 2007 Available from: https://www.who.int/teams/health-product-policy-and-standards/assistive-and-medical-technology/assistive-technology

[4] Hummelvoll JK. In: Dahl TE, editor. Helt - ikke stykkevis og delt: psykiatrisk sykepleie og psykisk helse. 7th ed. Oslo: Gyldendal akademisk; 2012

[5] Lindström B, Eriksson M. Contextualizing salutogenesis and Antonovsky in public health development. Health Promotion International. 2006;**21**(3):238-244

[6] Kuhn TS. The Structure of Scientific Revolutions. 2nd ed. Chicago: University of Chicago Press; 1970

[7] Askheim OP. Samproduksjon som velferdssektorens kinderegg. Tidsskrift for Omsorgsforskning. 2016;**2**(1):24-36

[8] Mohammed Ali A, Hogg P, Johansen S, England A. Construction and validation of a low cost paediatric pelvis phantom. European Journal of Radiology. 2018;**108**:84-91

[9] Nielsen LM, Berg A, Haakonsen P, Lysebo M, Lutnæs E. Education for new practice i – Technology, design and sustainability across professions. Forma. 2020;**13**(6):1-6

[10] European Commission, Directorate-General for Research and Innovation, LAB – FAB – APP – Investing in the European future we want: report of the independent High Level Group on maximising the impact of EU research & innovation programmes. Brussels: Publications Office; 2017

[11] Berg A, Groth C, Medola F, Sellen K. Co-creation of interdisciplinary design educations. In: Proceedings of the DRS LEARN X DESIGN 2021 6th International Conference for Design Education Researchers 24-26 September 2021 Jinan, China Engaging with Challenges in Design Education: Shandong University of Art & Design. Jinan, China: Design Research Society; 2021;**2**;476-478

[12] Antonovsky A. The structure and properties of the sense of coherence scale. Social Science & Medicine. 1993;**36**(6):725-733

[13] Mittelmark MB, Sagy S, Eriksson M, Bauer GF, Pelikan JM, Lindström B, et al. The Handbook of Salutogenesis. Cham (CH): Springer; 2017

[14] Abbott A. The System of Professions: An Essay on the Division of Expert Labor. Chicago: University of Chicago Press; 1988

[15] Vik E. Helseprofesjoners samhandling – en litteraturstudie. Tidsskrift for velferdsforskning. 2018;**21**(2):119-147

[16] Axelsson R, Axelsson SB. Integration and collaboration in public health-a

conceptual framework. The International Journal of Health Planning and Management. 2006;**21**(1):75-88

[17] Cai Y, Ramis Ferrer B, Luis Martinez Lastra J. Building University-Industry Co-Innovation Networks in Transnational Innovation Ecosystems: Towards a Transdisciplinary Approach of Integrating Social Sciences and Artificial Intelligence. In: Sustainability. Basel, Switzerland. 2019;**11**(17):4633

[18] Forsberg E-M, Thorstensen E, Dias Casagrande F, Holthe T, Halvorsrud L, Lund A, et al. Is RRI a new R&I logic? A reflection from an integrated RRI project. Journal of Responsible Technology. 2021;**5**:100007

[19] Yin RK. Case Study Research : Design and Methods. Vol. XIV. Thousand Oaks, Calif: Sage; 2009. p. 219

[20] Maxwell JA. Qualitative Research Design : An Interactive Approach. Thousand Oaks. Vol. XIV. Calif: Sage Publications; 2005. p. 175

[21] Gadamer HG. Truth and Method. London: Sheed and Ward; 1979

[22] Ihde D. Expanding Hermeneutics: Visualism in Science. Evanston, Ill: Northwestern University Press; 1998

[23] Repper J, Breeze J. User and carer involvement in the training and education of health professionals: A review of the literature. International Journal of Nursing Studies. 2007;**44**(3):511-519

[24] Daykin N, Byrne E, Soteriou T, O'Connor S. The impact of art, design and environment in mental healthcare: A systematic review of the literature. Journal of the Royal Society for the Promotion of Health. 2008;**128**(2):85-94

[25] Medola FO, Sandnes FE, Ferrari ALM, Rodrigues ACT. Strategies for Developing Students' Empathy and Awareness for the Needs of People with Disabilities: Contributions to Design Education. Studies in Health Technology and Informatics. 2018;**256**:137-147

[26] Westerveld E. The project excellence model®: Linking success criteria and critical success factors. International Journal of Project Management. 2003;**21**(6):411-418

[27] Scott KS. An integrative framework for problem-based learning and action learning: Promoting evidence-based design and evaluation in leadership development. Human Resource Development Review. 2017;**16**(1):3-34

[28] Star SL, Griesemer JR. Institutional ecology, 'Translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. Social Studies of Science. 1989;**19**(3):387-420

[29] Morassaei S, Di Prospero L, Ringdalen E, Olsen SS, Korsell A, Erler D, et al. A survey to explore the psychological impact of the COVID-19 pandemic on radiation therapists in Norway and Canada: A tale of two countries. Journal of Medical Radiation Sciences. 2021;**68**(4):407-417

[30] Hocking C, Whiteford GE. Introduction to Critical Perspectives in Occupational Science. Oxford, UK: Wiley-Blackwell; 2012. pp. 1-7

[31] Holthe T, Halvorsrud L, Lund A. Digital Assistive Technology to Support Everyday Living in Community-Dwelling Older Adults with Mild Cognitive Impairment and Dementia. Clinical Interventions in Aging. 2022;**17**:519-544

[32] Lowes L, Hulatt I. Involving Service Users in Health and Social Care Research. London: Routledge; 2005

[33] Lund A, Holthe T, Halvorsrud L, Karterud D, Johannessen AF, Lovett HM, et al. Involving older adults in technology research and development discussions through dialogue cafés. Research Involvement and Engagement. 2021;**7**(1):26

[34] Storås AM, Åsberg A, Halvorsen P, Riegler MA, Strümke I. Predicting Tacrolimus Exposure in Kidney Transplanted Patients Using Machine Learning. 2022 IEEE 35th International Symposium on Computer-Based Medical Systems (CBMS). 2022:21-23

[35] World Health O. WHO Laboratory Manual for the Examination and Processing of Human Semen. 5th ed. Geneva: World Health Organization; 2010

[36] Haugen TB, Hicks SA, Witczak O, Andersen JM, Björndahl L, Riegler MA. P–104 assessment of sperm motility according to WHO classification using convolutional neural networks. Human Reproduction. Oxford. 2021;**36**; i183-i184 (Supplement_1)

[37] Risnes M, Mellema M, Pinto-Orellana MA, Sherkat H. Enhancement of collaboration in the early stage of an interdisciplinary engineering and design project: mapping group dynamics. In: Bohemia E, Kovacevic A, Buck L, Brisco R, Evans D, Grierson H, et al., editors. DS 95: Proceedings of the 21st International Conference on Engineering and Product Design Education (E&PDE 2019), University of Strathclyde, Glasgow 12th -13th September 2019. Towards a New Innovation Landscape. 21: The Design Society; 2019. p. 6.

[38] Risnes M, Korostynska O, Mirtaheri P, Berg A. The role of human experience when making sense of brain monitoring: An interdisciplinary case study to assess wearable, non-invasive, brain-monitoring devices for rehabilitation. Journal of Responsible Innovation. 2023;**10**:1-20