

Using Futures Studies in Computing and Engineering Education: "Emergentist Education" in an Open-Ended Group Project

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Abstract—Researchers in futures studies argue that the future needs to be understood as uncertain, as not yet there. This renders mainstream educational discourses problematic, those that centre around the idea of preparing students for "the future", defining competencies and standards. In this work, we write about critiques of contemporary education and alternative conceptions of education drawing on futures studies as well as sustainability education research. We understand learning as an emergent phenomenon and describe a conception of education that we refer to as *emergentist education*. We apply those theories to an open-ended group project course at an IT department at a large Swedish university. In the course, the students and the teachers develop, together with staff from an Academic Hospital in Sweden, healthcare with IT. In an action-research approach, we analyse written and oral reflections from the various actors involved in the course with the aim to understand the course, its value and challenges in new ways. Analysing the data through the lens of emergentist education theory, we discuss three themes: 1) forces on openness, 2) orientations to the future, and 3) emergent collaborative learning and novelty. We find that the educators take the role of maintaining openness, while the students demand a clear project definition. The future orientation turned out to be mostly about correcting and optimising the present. Yet, this project led to mutual learning and new paths being taken. Education can be a place for creativity and novelty, and an opportunity for learning through joint endeavours.

Index Terms—computing education, higher education, project, emergentist education, futures studies

I. INTRODUCTION

What is the role of education in creating a better future? There has been little reflection in general educational discourse over how educators and students engage with the future [1]. Education has commonly been understood as preparing students for their future life, that is, preparing them to contribute to a better world in the future, as professionals [2]. How to achieve this is a complex issue. The dominant approach is one of standardization and control: What students ought to be learning is increasingly specified, which reduces possibilities of creativity and novelty [3]–[5]. In this paper, we review theories that help to understand education in different ways, ways that seek to foster students' free thinking and action.

Researchers in the fields of futures studies and environmental and sustainability education problematise the understanding of education as "preparing for the future". One issue raised is that preparing students for a specific future requires making

assumptions about this future [6]. However, we are living in a time of climate emergency that requires urgent and unprecedented changes in all aspects of our societies [7]. Consequently, we cannot know what future we are preparing students for. It is also questionable if education should be defined by a few people [5], or if education, and the world we live in, can be more of a product that emerges in the interaction between different people who meet around concerns [8]. Educators need to engage in the question of how they can take responsibility for enabling students to care for the future [9].

An education that seeks to support students in caring for the future needs to go beyond training and qualification [5]. It needs to become a process in which educators and students have opportunities to engage with the world in its complexity, to learn in creative, new, and unforeseen ways, and to become at ease with knowing and not knowing [1]. Learning in such a process should be understood as something that emerges in interaction. If education is to allow for change and for new ways of thinking and living, then openness is important [5].

Theories supporting such new ways of conceptualizing education exist but have not yet become a part of the broader educational discourse [9]. They come from the fields of futures studies and environmental and sustainability education (ESE, also referred to as education for sustainable development). There is no one term that is broadly used to refer to such conceptualisations of education or pedagogies. Researchers write about "learning as an emergent phenomenon" [3], and an "emergentist relationship to the future" [4]. The term "emergentist education" is also being used in translator education [10]. Peters is working with researchers from ESE and futures studies, proposing the term "emergentist education" and its use for sustainability education.

The current paper uses emergentist education theories to reflect on an open-ended, project-based course within a computing education programme. The course, called "IT and society" [11], [12], requires students to address a wicked problem formulated by IT managers at the local University Hospital. The pedagogical idea is to give the students responsibility and freedom to organise themselves and develop the project as they, through their collaboration with the hospital staff, see fit. The project and students' learning are planned only to a

limited extent and emerge during the course.

The idea of this paper is to use the emergentist education theories to conceptualize and further develop the course from this perspective. We have been developing the course through research for 20 years. Compared to the other courses at the department, it is very different in many ways. Some students appreciate this course, while others, along with directors of studies, question its relevance [13]. By looking at the course through the lens of emergentist education, we aim to better understand and make more explicit some of the pedagogical ideas and approaches it makes use of. Important goals with this work are to better understand our roles as teachers, as well as how to argue for the value of this course for students.

II. THEORY OF "EMERGENTIST EDUCATION"

We begin with a short section on the criticism of contemporary education by emergentist education theorists, and then move on to introducing emergentist education theories.

A. Criticism of Contemporary Education

Contemporary education is increasingly being standardised. Osberg and Biesta [3, p.6], for example, argue that higher education today can be conflated with curriculum, leaving little "opportunity to theorise education as anything other than an instrument designed to achieve a predetermined socio-political product". In contemporary discourse, education is reduced to a mechanism, a normative tool. University education is also increasingly being used and controlled as a means to serve industry needs, to serve a neoliberal market agenda, to ensure competitiveness in the global knowledge economy [4].

Education in technical fields is often highly constrained. For example, research in engineering education suggests that students in engineering lose interest in social questions [14]. Malazita and Resetar [15] argue that computer science students are formed into "anti-political beings". Peters' [16], [17] research shows how computing education encourages students to perform narrow technical identities. A large body of research on gender and technology suggests how disciplines within technology are co-constructed with masculinity, meaning that technology gets meaning through the ways that masculinity is defined and vice versa [18]–[21]. For instance, a recent study by Ottemo et al. [21] suggests that physics and engineering are "masculinised" by asserting that style and corporeal aesthetics should not matter in these fields.

However, education and technology change, and identity discourses are continuously renegotiated. Understanding education through emergentist education theories can help understanding contemporary education and its limitations, as well as support change. In fact, emergentist education is "a resource for resistance to homogenization, a way to place pressure on the routines demanded by technical and technological standardization", as Sarah Amsler phrases it [22, p. 929].

B. Emergentist Education

How can educators and education researchers understand and relate to the future? The dominant future-orientation in

education is that the future is something that can be predicted or foretold [1]. Education is understood as an instrument to act upon those predictions of the future [6]. The students are "optimised" to make better education choices and to be better prepared for the future. Using education as a means to reach a better future also colonises the future with our current assumption of the future and what more sustainable ways of living look like. However, the future can also be understood as unpredictable or uncertain. Acting only upon the predicted or envisioned future is a "denial of the unknown, or incalculable, and hence a denial of the future in its radical futurity" [9, p. 166]. Taking the future seriously might mean to see the future as a "construction site" [4], as something that is open to being constructed, as a "site in which novelty is possible" [1, p. 73]. Education can be a domain that invites people to take part in constructing, imagining and re-imagining the future. Envisioning futures informs reflections on and actions in the present. By making space in education, allowing diverse students or stakeholders to meet around matters of concern in less constrained ways, education can become a place in which learners and the world co-emerge [6], [8], [9].

What would an education look like, in which people can take responsibility to care for the future? Deborah Osberg [9] argues for an "edu political" understanding of education. Education can be a domain that invites all people to creatively engage in imagining and re-imagining the future. It should be a democratic space. In fact, it may be, as Osberg argues referring to Derrida (1992), the only domain in which people are free to "experience and experiment with the possibility of the impossible", and in doing so create something that is radically new in the present [9, p. 167]. Opportunities of creating ways of living and knowing that are radically different from what exists today is what we need in times of climate emergency and other sustainability challenges. This freedom and the opportunities to imagine alternative futures is limited in politics, because this domain is constrained by the needs to make decisions. Here lies the potential of education, being a place where diverse people can meet to 'invent the new', imagine that which is not yet imagined.

Universities can be a place for inventions, a place where students (and educators) are free to imagine different futures [5], [23]. Fulfilling this potential of education requires, as Keri Facer argues, engagement with the future in open-ended terms, in ways that build upon complex understandings of the present and the past [1]. In this context, the educator's role is to create spaces and practices that enable radically new possibilities in the present [1, p. 70] or, in other words, to maintain a space in which "freedom can appear" (Gert Biesta citing Hannah Arendt [24, p. 539]).

The future and education then should be understood as an emergent phenomenon [3]. Learning here is not only about objective facts and competencies. Instead, learners get to engage with conflicting forces and values in communities [1], [8]. They learn about harmful structures and are invited to have conversations on how such structures may be dismantled [22]. Rather than seeing sustainability as a set of expert-derived

practices, it can be understood as an “emergent property of conversations about desired futures that is informed by understandings of the ecological, social, and economic consequences of different courses of action” [8, p. 185]. As such, sustainability can become everyone’s responsibility and also an aspect of many parts of education. While sustainability is seldom brought up explicitly in the course we are reporting on in this paper, the project work is essentially about sustainable health care, using resources in a way that is fair and sustainable over time.

Providing space for radical futurity, that is, allowing for a future that is radically different from the present, entails trust. Such an idea of education cannot mainly be about efficiently reaching certain educational goals. The educational encounter can rather be understood as a “relaxed form of knowledge and being in the world ... confident in its capacity to create the conditions of possibility without seeking desperately to secure their outcomes” [1, p. 76].

Subjectification, as is described by Biesta [23], is a useful concept to understand education with the purposes described above [5]. Subjectification is, according to Biesta, one of the three tasks of education besides socialisation, and qualification. Socialisation entails adapting to norms and values, *qualification* is about gaining knowledge and skills, and subjectification entails a “qualified freedom” to exist in and with the world [25]. While socialisation and qualification seek to integrate individuals into pre-existing orders, subjectification grants individuals the right to reflect on and critique existing orders and power relations. It is a process through which an individual becomes a subject of action and responsibility [24].

Earlier we have argued that emergentist forms of education support understanding limitations of contemporary education and change. Anne-Katrin Holfelder [5] talks about emergentist forms of education as an ideal. Yet, Amsler and Facer [4] say that alternatives to contemporary standardised education already exist. We argue that the IT in society course could be seen as such an alternative. In spite of this, this work is the first time we use futures studies to reflect on the course.

The work on education in the field of Futures studies, which we have presented above, is a rather new body of work that has hardly been used in engineering and computing education. There, we find work that presents views of education or university in the future [26], [27]. Researchers have also studied how students imagine “their futures” [28], [29]. Additionally, De Vos et al. [30] make use of design thinking and futures studies techniques to foster creativity in students. Yet, the broader discussions of what education should look like and aim to achieve, as reviewed here drawing on sustainability and futures studies, are not visible in computing and engineering education. In the following, we explore how those theories can inform educational initiatives such as the open-ended group project this paper centers on.

III. THE IT IN SOCIETY COURSE, AN OPEN-ENDED GROUP PROJECT COURSE

The “IT in society” course is given at a large, research intensive university in Sweden. Students from different computing programmes at later stages of their education are invited to take the course. It is very different from the other courses offered at the IT department. The students are given a lot of freedom to develop and engage with an external stakeholder on a complex question that is not formulated as a technical question. This is something the students are not used to and it conflicts with identity and values in computing education [16], [17].

During the course, which lasts for a whole semester, a group of about 15-30 students (16 students this year) work half-time on an open-ended group project [31] that has been loosely defined by IT managers at the local University Hospital. Usually, the problem formulation is future oriented. In previous years, students for example got to work on envisioning Healthcare in 2025 or the digitalization of primary care in 2030. This year, the hospital’s team asked students to examine what patients’ involvement in their care could look like in the future.

The course is set up so as to allow students to work independently with some guidance from teachers. During the first couple of weeks, the teachers introduce the course’s pedagogical underpinnings and building blocks, but then hand over the control to the students, who decide over the work they want to do and organize themselves in groups to get it done. They collaborate with and get feedback from staff at the hospital, whom they regularly meet. For instance, this year, students had short meetings with the hospital staff every week. The course requirement is for the students to present their work to stakeholders at the hospital orally and to submit a written report to the hospital at the end of the term. No specification regarding the content of the presentation or report is set at the beginning of the course; they emerge throughout the course as the students progress with their work and engage with the hospital’s team. A consequence of this is that the direction and focus of the course’s project can change drastically. Changes can be initiated by both the students and the hospital. For example, in a previous instance of the course, the hospital’s team asked students to co-write parts of the final report in a EU project, while they had originally only requested students to observe and comment. Another year, students produced a white paper which was used as a basis for a large EU project. This illustrates the real-world impact the students can have through the course.

During the past 20 years that this course has been taught and improved upon based on research, different versions of scaffolding have been implemented and evaluated [11], [32]. They fit well into the framework of emergentist education. One example are the reflection exercises [33], especially the learning agreement exercise [34], [35]. Professional competencies are being used to lift learning beyond technical skills and knowledge [36], [37]. In light of emergentist education theories, we explicitly encourage the students to continuously

engage in adapting and refining their learning agreement and in learning with and from other students and the hospital. As teachers, we know that it is difficult for students to be aware of their learning, as it is not measured as a number at a final exam and is happening gradually during the course [38]. Introducing and using professional competencies and the learning agreement makes this somewhat easier. Those reflection assignments are similar from year to year, though they are usually slightly adapted to fit the specific course project. The students work in smaller groups that are supervised by a teacher. These smaller groups are all part of a main project, and the final presentation and report bring together the contributions made by all groups. Usually, one sub-group coordinates the writing of the report. This sub-group has in the previous years created a writing assignment for their peers with the help of the teachers. In this assignment, each student is asked to write a short text that can be used in the final report. The students then review each other's work and, in a third step, reflect on and address the comments they received from their peers. Another sub-group, usually, includes the leaders of the whole project team and the leaders of the sub-groups. The leaders often meet weekly to organise and reflect on leadership, and are also supervised by one of the teachers. The teachers' role throughout the course is to support the students, ask questions, and make suggestions. The teacher is mostly an observer and assists when the students ask for help. The students are allowed to follow their ideas through even when they seem less than optimal from the teachers' point of view.

The course is received by the students in different ways. Some students appreciate the opportunities of this course, while others reject it as they perceive that they do not gain enough (technical) skills from it [13]. The course is very different from other courses at the IT department and provides other opportunities than traditional education. It also raises concerns, both for students and for directors of studies. The course is being attended by more exchange students than Swedish ones, which may be a result of the prevailing perception that students do not learn so much in this course. Exchange students bring in a diversity of perspectives and experiences, which is valuable. However, the low number of Swedish students means that there are few students who speak Swedish and have experience with the Swedish healthcare system, which is a challenge to deal with. The low number of students from the IT department attending the course is another reason why understanding the value of the course is important.

IV. METHOD

This work is action research [39], [40] with the aim of understanding the course, especially its value and the challenges it brings about, using the theories of emergentist education (see Section II-B). The theory can be used to direct the researchers' observations of what is happening in the course (e.g., social interactions), as well as the reflections of the interaction between the stakeholders (students and hospital).

The teachers, who are also the researchers and authors of this paper, met every week to share their observations

from supervising the smaller student groups and discuss how to respond to the students. The authors Anne-Kathrin Peters and Mats Daniels are researchers in computing education, Diane Golay is a researcher in human computer interaction doing research at the hospital. Peters has been familiar with the theories. As course responsible, she led the discussions, informed by theory. For the other authors, the theory was new.

The findings we present in this paper are based on an analysis of the following materials:

- 1) The written notes we, teachers in the course and authors of this paper, wrote during our weekly meetings throughout the whole duration of the course.
- 2) The written notes from a final meeting with the hospital where we had an open conversation about their experiences during the course and ideas for how the course could be improved.
- 3) The written and oral student reflections from the end of the course. In the last weeks of the term, the students had to hand in a written assignment in which they reflected on their personal engagement, the work in the smaller student groups, the contact with the hospital, the project work as a whole, the reflection assignments and especially the learning agreement and its use. This written assignment was a basis for a final reflection meeting, which we prepared as a semi-structured interview. The following is a list of lead questions and examples of follow-up questions:
 - a) Can you summarize your journey throughout the course? (e.g. what were your best and worst moments?)
 - b) What do you think are the effects of the course? (e.g. takeaways, impact on the hospital work)
 - c) To what extent do you feel you were able to use and contribute with your personal experiences and interests? (e.g. what experience did you bring in?)
 - d) What did you find particularly valuable about the learning environment for your learning and the impact of the project?

This paper presents an initial analysis of the student interviews and teacher notes. Having conducted the interviews and read parts of the reflections, the authors together identified preliminary themes to structure the presentation of the findings and the discussion. Those themes were used to revisit the data to collect relevant excerpts and relate them to each other, to make cohesive arguments.

V. FINDINGS

We identified three main themes by analyzing our data through the lens of emergentist education theory: 1) forces on openness, 2) orientations to the future, and 3) emergent collaborative learning and novelty. In the following sections, we present each one of these themes and reflect on their meaning for the value of the course and the challenges it brings about.

A. Forces on Openness

As described in previous papers about the course [41], [42], students often have negative initial reactions to the open-endedness of the course and the freedom of action they are given. Many students have reported feeling confused and disconcerted upon starting the course. They see the time spent exploring different plans of action and acquiring general background knowledge about healthcare in Sweden (that may not be directly relevant to the project) as wasted. They are unsure if what they do in the beginning will be relevant for the final product (the presentation or report), and even though this early work, in any case, is valuable preparation, it is perceived as ineffective and a waste of time. As a result, some students disengage from the course during this initial phase and take on a passive role, choosing for example to focus on other courses:

We wasted quite a lot of time and I realize that now that I look back, however, we were very confused in the beginning so I think it was because of that. I personally could have been more engaged and made sure that we knew what we were supposed to do.
(final student reflection)

Disengagement or loss of motivation can also come from a sense of overwhelm, a perception that the task is too big and complex to be manageable.

Students' reactions have been challenging for the teachers to deal with. On the one hand, emergentist education theory suggests that freedom and "relaxed forms" of doing and learning without securing outcomes are important. In fact, the difference of the learning environment also triggers student reflections on education in other courses. The following reflection comes from after the first intensive working week in the beginning of the course. The student realises how much her learning activities have been defined by others in all other courses:

The first week of this course was challenging, confusing, and interesting. This course was the first course in my twenty years of study that I was not given a clear description of what I am to do. This made me realize how much I am used to being told what to do at least within institutional education.
(student reflection after the intensive working week early in the course)

This reflection shows that confusion is not necessarily negative and should not be completely avoided. In fact, not being told what to do and learn might be necessary for the students to think about their unique ways of contributing and their own learning goals. Interestingly, by the end of the course, many students seem to have made sense of the course and its pedagogy:

The course had some kind of harmony. In the end it all made sense. I could have been more attentive.
(student final reflection)

Variations of the expression "could have done more" are often stated in the final individual reflection meeting.

Above, we give perspectives on how openness can be beneficial for learning, yet, if the negative feelings experienced by students at the beginning of the course lead them to direct their attention to other courses, there is a risk that they miss out on opportunities and fall behind. It may thus be detrimental to their ability to contribute to the project in an active and meaningful way, resulting in only a few students in the group taking responsibility for and investing time and energy into the project. Students' reflections and teachers' observations throughout the course also highlight the high demands that an open-ended, independence-oriented course places on students. For some students, for example those who struggle with English, these high demands may be an excluding factor, preventing them from taking an active role in the course. Here lies a tension that we as educators have to deal with: allowing for or maintaining freedom vs. giving directives or suggestions for what and how to do.

Maintaining the open-endedness of the project beyond the first couple of weeks has been a challenge. At the beginning of the course, both the teachers and the hospital staff conveyed the importance of openness to the students. The hospital staff for example told the students to look into "everything" related to patient-centred care and IT in order to be able to "zoom in" and "zoom out" (teacher notes Sep). However, two weeks after the project topic was introduced to the students, the hospital talked to the students about a definition of the project scope. As teachers, we were surprised as the students had done little research on the topic and had not collected any data. One explanation could be that the hospital succumbed to the students' demands to be told what to do. The students reacted to the narrowing down of the project scope by saying that they "were waiting for this" and that the project finally felt like "one project". Another group was expressing a similar relief and created a document "What the client wants" (teacher notes Sep 30). Some students found the scope not narrow enough, and there were also some students who found the scope too narrow (teacher notes Oct 2). In the teacher meeting, we decided to communicate to the students, if needed, "that this is only a preliminary version of the scope, the students should continue to understand the whole picture and to search for interesting questions" (teacher notes, Sep). Inspired by emergentist education theory, we asked the students to pay attention to that which emerges in social interaction, which had not been foreseen.

In the case described, and also a common occurrence in subsequent instances of the course, the messages to the students from the hospital and the teachers were in opposition or in competition. The hospital took the role of telling the students what to do, while the teachers were telling the students to think freely and creatively, making use of their unique backgrounds and experiences to allow for the opportunity to contribute in ways that had not been anticipated by the hospital. One example of this was that the students in one group discovered through interviews that "feedback systems" for patients would be interesting to look into more. The hospital told the students not to follow up on this idea. However, as teachers, we saw that

the students had interesting ideas and experiences. Therefore, we encouraged them not to dismiss the idea, possibly to bring it up later (teacher notes Nov 3). Feedback system appeared several times during the further research but the project leader decided not to take those ideas further nor to bring up those ideas at the meetings with the hospital. However, the project members argued for their ideas at the final workshop, which turned out highly appreciated (see Findings Section V-C).

Finally, as teachers, we saw that the structures that the students decided on to work in the project impeded on individuals' freedom of participating in the course and learning. Some students experienced that the overall group structure and leadership type adopted throughout the project constrained their freedom and ability to be active and "thinking" participants in the course, which negatively affected their motivation. One student wrote:

The way the project groups were divided with only a few people having direct contact with the hospital for the first month and a half of the project, probably made the rest of the group feel excluded and hampered motivation even more. I raised this issue and the whole project group was invited to the weekly meetings with the hospital after the mid term presentation. But I felt that people had already settled to their roles in the project and the motivation stayed on the sub-optimal level throughout the project."
(Student final reflection)

As is pointed out in previous work, e.g. [43], leadership can be a challenge in complex project work and the students may be little prepared. In this course instance, the leaders were dedicated and reflective. Yet, as the student reflection above shows, decisions by the leaders resulted in certain structures and student engagement that was difficult to change afterwards, possibly also because the students react in certain ways: They do and learn as they are told. As is described in [43], the leaders also described that the communication in between groups is limited (teacher notes Nov 6). Also here, one explanation might be that the students accept the limited scope of their work and do not feel responsible for the broader scope of the project. Students in computing are used to a divide and conquer approach to solving problems [16], [17]. This can hamper communication and limit possibilities for collaboration and novelty across groups.

While we as teachers were trying to create a space of freedom for students, we at the same also allowed for a structure to emerge that reproduced a strict hierarchy and resulted in "unequal" freedom across students. We reflected on such observations in the teacher meetings and brought up questions that would allow the students to reflect on and question their decisions. As we have described, there are different forces that make the project work less open, close it. This is natural and probably necessary to achieve a goal. The role of the teacher can be to be sensitive to the ways in which freedom is constrained and to help the students reflect on this. A question remains about the extent to which freedom

can be "imposed". We also wonder how a personal sense of freedom and autonomy can be fostered in each student.

B. Orientation towards the future

Even though the problem description was future-oriented, the work turned out to be more about the present. In the teacher meeting about three weeks after the project had been introduced, one of the teachers reflected:

"It feels as if they [the hospital staff] want to have an analysis of that which exists."
(teacher notes, Sep 25).

In this project, the future seemed to be mostly understood as a continuation or gradual, minor correction of the present. For example, in October a sub-group leader communicated to their subgroup that the hospital wanted to know how the current systems could be improved. The supervising teacher told the students that their role was wider than executing orders, that they had agency and could use their skills to think critically and put their own spin on the "assignment" (teacher notes Oct). Futures thinking and design thinking skills, as they are e.g. presented by De Vos et al. [30], might be useful for our students as well, something we could point them to.

Yet, the orientation towards the future as a minor correction of the present, might be somewhat natural, considering the complex realities at the hospital. The present state at the hospital is characterised by a variety of complex issues, including a large number of non-integrated, off-the-shelf systems from different vendors, a variety of use contexts and user roles across the hospital, and managerial drive to standardise care processes.

Considering the sustainability challenges we as a global society are facing that require unprecedented changes and societal transformation, engaging with the future in less constrained ways, allowing for futures that are radically different from the present, is important. The role of education could be to allow students to engage with the future in different ways. The course provides such opportunities. Also in this year, the teachers advised the students to creatively think about different futures. Here we see a need for more scaffolding. In previous years, students did engage with the future in more creative ways. One year, the students learnt about and conducted vision seminars where they discussed desirable futures in more open ways [44].

C. Emergent Collaborative Learning and Novelty

We here want to reflect on that which emerged, was unexpected, even surprising. The theory suggests that education can be a place for invention and here we think about what was invented, how the students contributed to the work at the hospital and to future healthcare. We discuss joint learning that grew out of the collaboration between the students, the hospital, and the teachers. Some of the potential for creativity and novelty might lie exactly in the tensions and struggles to deal with the complexity and the future in open ways that were described under the previous two themes.

The students came up with structured processes to reflect on, talk about, and continuously re-negotiate their learning, with support from us teachers. In previous years, the students individually took responsibility for their personal learning agreements. Reflections with the teachers happened in the beginning and in the end of the course. This year, some students used a spreadsheet to reflect on their learning jointly and, on a more regular basis, giving each other feedback. This process was not attended nor stimulated by the teachers. How to "keep the learning agreements alive" was also discussed with the project leaders in the project leader meetings (teacher notes Sep). They then discussed learning with the peer students taking part in the sub-group meetings every other week.

Doing research and communicating results was challenging to the students. The project leaders asked for seminars on writing and presentation techniques that the teachers helped organise by setting the students in contact with potential instructors (teacher notes Nov 10). As teachers, we also saw that the students needed much support conducting and analysing interviews. We became aware of how little experience the students had with methods such as interviews. As is found by Grabowski et al. [43], doing this project in a large group was challenging:

It seems that there is no alignment between groups when it comes to what the analysis should unfold and what the findings should be about, and how these two things relate to the patient contract and a shift towards more patient-centered care. Here I think the leaders have a role to play.

(Teacher notes Nov 27)

What was satisfying for us researching professional competencies and identity was student reflections that acknowledged the complexity of developing healthcare with IT. For example, in the following student reflection, the student talks about the limitations of technology, "enough technology may be enough". The student, at least to some extent, has realised that being a computing professional goes beyond creating technology, which is a dominant discourse in computing [16], [17], but also involves being critical to using technology.

I did not realise they struggle so much [in healthcare]. I think we need to find solutions so that the elderly, or those who need it, still can have face to face meetings. Enough technology may be enough. We must think in other ways, we cannot just throw technology at people.

(final student reflection)

We also observed mutual learning between students and the hospital. The hospital was committed to working with the students and even extended the time they set out for supervision (teacher notes Nov 6). The students reflected that they found it surprising that the hospital really was so interested in their work:

I had a little bit of prejudice the first time I heard we were going to work with the hospital and thought that they would probably not take our work seriously

and be so engaged, especially because they have a lot of work to do now during the pandemic. However, after the presentation, I realized that it was the complete opposite. They were listening very carefully during our presentation, and the questions they asked [...] all indicated that they were very interested in what we had to say and that they were listening very carefully.

(final student reflection)

This year, the students presented their findings in an hour-long presentation followed by a workshop with the audience members, most of whom were affiliated with the hospital. The workshop consisted of smaller group discussions on topics that had emerged during the project work. In one of the group discussions, the students explained their views on how data could be analysed to gain feedback on patient care. While feedback systems had been dismissed by the hospital earlier, the students now convinced the hospital managers that this is an interesting topic they need to work further with. In the meeting with the hospital staff after the course, it was said that working with feedback system now was a top priority. This result has influenced next year's topic. The students will work with decision support systems. The following quote illustrates how the students and hospital staff have learnt to work together, and learnt from each other.

Teacher: What was the best moment for you?

Student: Maybe the final presentation, and the workshop, I felt really excited and happy. Because it turned out that our final research really was valuable to them. [...] Also, we discussed further our work [on feedback systems] that seemed to have served as a starting point.

(final reflection meeting transcript)

As in previous years, the students were invited to present and discuss their results at a conference. The project leaders submitted an extended abstract to a large industrial medical IT conference which got accepted after peer review.

VI. CONCLUSION

The theory of emergentist education, conceptualising education as an emergent phenomenon, turned out to be a valuable theoretical lens through which to understand and improve the IT in society course. The course is an example of a learning space where students do not only learn that which has been predetermined and set out to be learnt. Instead, learning unfolds as the students, the teachers, and the external stakeholders, the hospital staff, engage with healthcare and the opportunities and limits of IT in that domain.

In this paper, we argue for openness or freedom as crucial for change and novelty based on theory and empirical work. Unprepared for such freedom, students are often confused especially in the beginning of the project. They demand and create structures and define scope. This "closure" in the ways in which the students engage with the theme is natural and helps the students to do the work. Yet, this behaviour

also reduces opportunities for new and different approaches, ways of thinking and collaborating. In future instances, all stakeholders (not just teachers) could be made aware of the notions of closeness and openness so that they can consciously reflect on decisions to narrow down or broadening the project scope. In this course instance, only the teachers were aware of the theory. Their power to question decisions to constrain openness was limited.

The analysis of the IT in society course we have developed in this paper brings forth several implications and ideas for course development and future research. This work will inform teachers' supervision of students in future instances of the course and their communication with the hospital. For example, during our last meeting with the hospital, we reflected on how this course can be an opportunity for them to gain new, unexpected ideas and knowledge. Openness, withstanding the students' calls to be told exactly what to do, is a necessity. It also helps the teachers to explain the course to the students and to have a shared understanding on the teachers' role. This work suggests that the teachers' role is not only about maintaining openness but also about ensuring that the openness is constrained consciously. The teachers can also be the ones remembering and reminding that decisions do not have to be definitive - structures can be changed, scopes can be opened up again. Finally, we as teachers will consider pointing the students to futures thinking and design thinking techniques, as is for example described in [30].

We conclude this paper with a summary of the value and beauty of a course built on emergentist education theory. The course shows how education can empower students to contribute to complex challenges in the present instead of being limited to preparing them to do so in the future. In fact, providing students with a voice and an agency for "action now" is an important preparation for the future, in which students, being well educated, are likely to find themselves in a position where they are not being told exactly what to do. Being attentive to that which emerges in social interaction and collaboration seems both beautiful and hopeful in these times that call for change and creativity. Such opportunities of education should not be reserved until the very end of graduate education. In the future therefore, we can build on this work and find out how emergentist education can inform other project work or other education initiatives.

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