Digital collaborative problem designing in an interdisciplinary setting

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ABSTRACT

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I Background & Explanation

New complex problems emerge and with global challenges like sustainable development (SD) and Industry 4.0 there is a need to change the educations accordingly (Kolmos 2021). Engineers are an important resource regarding technology development, and the complex problems increasingly demands competences like interdisciplinary collaboration across disciplines and programs and project management skills (Hadgraft & Kolmos 2020; Kolmos et al. 2020). Since the foundation of Aalborg University (AAU) in 1974, the university has worked with problem-based learning (PBL) as the pedagogical educational methodology. In a PBL learning environment the problem is the point of departure for learning and it is important that the students learn to identify, analyse and formulate problems themselves (Holgaard et al 2017). Previously, the main focus has been on what Ryberg et al. (2018) denotes as small-group PBL - work in static groups within disciplinary teams (monodisciplinary), which has been implemented with success for engineering students (Times Higher Education (2021); US News & World Report 2021). However, complex problems represent a new class of problems that challenge the students and introduce a requirement for interdisciplinarity (Kolmos et al 2020; Klein 1996). In autumn 2019 Aalborg University introduced Megaprojects that incite students to work on complex global problems related to the UN's 17 Sustainable Development Goals (SDG's) (Aalborg University 2020). Two years after the initiation there are still challenges with the Megaprojects (Routhe et al 2021; Winther et al 2020). In particular, students struggle with 1) The depth of multidisciplinarity when working with complex problems. Different problem types and contexts call for different types of execution and decisions (Snowdon & Boone 2007) and it may involve different levels of disciplinary and interdisciplinary approaches (Kolmos et al 2020). By definition, the solving of complex problems requires a high level of multidisciplinary understanding and teamwork, and contextual awareness that students have not faced in their previous schooling years. 2) Outlining and understanding their own and others' disciplines. When students are working across disciplines it is important that they understand their differences and mutual dependencies (Routhe et al 2021) or else they are only working in their own domain and complex problem solving needs solutions from multiple disciplines.
This contribution introduces an activity for digital collaborative problem designing in an interdisciplinary setting that facilitates student reflection on contextual awareness and depth of multidisciplinary projects by visually outlining the problem and potentially necessary domains of collaborative partners.

From a progression and assessment point of view this activity answers to several ILOs of PBL. Recent research at AAU has exemplified four types of generic PBL competences: problem-oriented, interpersonal, structural and meta-cognitive competences (Holgaard & Kolmos 2019). Students must be aware of the

competences, tools and methods they have acquired during their time of study, both in terms of domain specific knowledge and generic PBL competences. Newly research have found that students' PBL competences becomes tacit during their study time, giving them a limited or none language to articulate what is needed in different collaborative problem settings (Holgaard & Kolmos 2019). This is an issue, not only in terms of future employability and articulation of competences, but also in terms of emphasizing and using the progression of competences the students experience during their time at the university into more complex interdisciplinary settings. Focus in this contribution will be on the problem-oriented and meta-cognitive competences with point of departure in the following question: How can students at AAU be supported to create a progression in their competences of working with interdisciplinary problem identification and problem analysis using a digital learning activity?

II Set-up and expected outcome of a PBL workshop on Interdisciplinary Problem design

In spring 2020 the first PBL workshops were launched for students at the Technical and Engineering faculty at AAU. The Aalborg PBL centre offered a number of PBL workshops all elaborating on different PBL competences expanding students' PBL toolbox.
One such workshop was the Interdisciplinary problem design. The aim of the session was for students to get a better understanding of how to approach and work with an interdisciplinary problem design. 7 programs chose this workshop spanning from 2-6 semester from both Aalborg and Copenhagen. Due to the pandemic Covid 19, the workshops were fully online, fostering new possibilities for online collaboration.

For the workshop the platform MS Teams were used, giving the possibility for sharing information and facilitating the online workshop. With and aim to give the students as much interaction and activities as possible, the platform Padlet was used as a collaborative whiteboard for sharing inputs and ideas.

The workshop lasted approximately 3 hours with an exchange between lecturing and team work in smaller groups. In the beginning of the workshop, it was important to create a common ground for the students, letting them discover their shared and opposite understandings of interdisciplinarity. In addition, the students were asked to reflect and elaborate on the concept of an interdisciplinary problem design: When is a problem design interdisciplinary and have they ever experienced this kind of design before? For this part of the workshop Padlet was used as a platform for noting findings and reflections from each group. The group work was followed up with a plenum discussion of the input noted in the Padlet.
After a plenum sharing of understandings of interdisciplinarity and interdisciplinary problem design, a slideshow was presented to give the students a better understanding of the context working in. With point of departure in Stock and Burtons (2011) explanation of interdisciplinarity as a way to try and "*break down methodological, epistemological and ontological boundaries that prevent shared understandings of complex issues",* students were giving insight to the contextual background for why we talk about interdisciplinarity. Snowdon and Boone presented in 2007 an illustration of ordered and unordered problem types giving a theoretical understanding of the progression of problems from simple to chaotic (Snowdon and Boone, 2007). Kolmos et al. (2020) combined this framework with the problem-based learning approach to problem solving illustrating the differences to project types, problem design, project management and collaboration. Combining this understanding of different approaches to problems with different degrees of interdisciplinarity, students became aware of the dependency and causality between problem types and teams of collaboration. As Interdisciplinary is a common concept used to describe integrated research it is important that the students are aware of the range of stages presented in interdisciplinary research ranging from borrowing to transdisciplinary collaboration (Klein, 2010) With an understanding of different problem types in combination with different approaches of collaboration, students will be able to assess what is needed in different stages of their project work.
For the second group activity, the student groups were asked to do a concept map of Covid 19 or sustainable construction depending on the discipline (see appendix 1 for examples). By choosing a broad case for this

activity, it was possible for the students to make a general brainstorm of aspects and inputs to the case. The activity took place in Padlet where all groups had access to the same whiteboard. The activity was divided into two phases with the first being a general brainstorm of the case working on. Students should try not to limit their focus to their domain specific knowledge, but broaden their understanding and perspectives of the case more in general. In the second part of the activity, students combined their overall brainstorm with their domain specific knowledge, elaborating on what they as engineering or technical students could give insight and inputs to. But also, what kind of problems that were out of their expertise. Having all these considerations in mind, it was possible for the students to relate the different post it's of problems or focus points to one another. Doing so, the students got a concept map that visualized the complexity of the case working on. The map may seem confusing or unmanageable for the students, but the task is then to recognize the complexity of the topic and try to figure out which relations are essential for the given situation in the case and which that is possible to leave out.

With the above inputs, the last activity was focused around the student's semester projects. With point of departure in their current project work, students were asked to elaborate on the problem type, degree of interdisciplinarity and to investigate if elements in their problem analysis could benefit of inputs from other disciplines. Doing so, students become aware of possibilities for collaboration with other disciplines in their current project work, but also which elements in their project work that has roots in other disciplines.

The session ended with a reflective part, where students had to articulate which competences they have in relation to interdisciplinary problem design. Students were asked to answer questions as: When is interdisciplinarity needed, how has previous experiences with working interdisciplinary been (of any) and what are the differences between disciplinary and interdisciplinary work?

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Appendix 1