Skills for learning across disciplines in project-based learning

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ABSTRACT

Education focusing on developing interdisciplinary skills is gaining traction in Higher Education. Often this type of education takes shape through project-based learning. Prior research shows that the focus of such interdisciplinary learning should lie on attaining synthesis and that the end result of an interdisciplinary project should be more than the sum of its disciplinary parts and be truly synergetic. Two important prerequisites of successful interdisciplinary (project)work are reaching a common goal in which each discipline is of added value towards synthesis and attaining a common ground of methods, concepts and views.

In this research project, the focus was on mapping if students were able to reach a common ground and synthesis during working on an interdisciplinary project. The context is the Smart Solutions Semester of Saxion University of Applied Sciences, where third- and fourth-year students from three or more (engineering) disciplines work together in project teams on large (25 ECTS) projects, provided by research groups and the business community. A learning activity was developed for and conducted with four student teams after which semi-structured interviews were held with the students and corresponding tutor. Results confirm the importance of a common goal and common ground. Additionally, results show the importance of fostering interdisciplinary exchange and the crucial role of the tutor in guiding students toward synthesis.

1   INTRODUCTION

1.1 General introduction

Complex challenges in society ask for innovative, out of the box, solutions. These solutions often take shape by utilizing various perspectives and ideas, both within and between disciplines. Interdisciplinary group work is increasingly present at universities, focused on fostering skills for students to work on these complex challenges. At Saxion this takes shape in the Smart Solutions Semester (3S). In this semester students from various disciplines work together in project groups on large, complex challenges which are provided by the business community and research groups. One of the goals of the 3S is to challenge students to cross their disciplinary boundaries towards creating 'smart solutions'.

1.2 Theoretical Framework

Various definitions and interpretations of multi- inter- and transdisciplinarity exist. During this research the following definition of interdisciplinarity has been used: *"The capacity to integrate knowledge and modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement, such as explaining a phenomenon, solving a problem, or creating a product, in ways that would have been impossible or unlikely through single disciplinary means"* [1. pp. 219]. In concrete terms this means that **synthesis** between disciplines is crucial on both the project level and the subtask level [2].

Four processes are key to interdisciplinary collaboration [2].The first being **setting common goals**. This first step concerns matching the correct disciplines to the complex challenge at hand and identifying the added value of each discipline. Subsequently a **common ground** has to take shape. This entails further exploring the added value of each discipline concerning knowledge, methodologies, terminologies etc. to obtain a common framework from which the challenge can be addressed. During the entire project it is important to foster an attitude of **critical awareness**, e.g. being able to constantly reflect on the possibilities and limitations of each discipline concerning the complex challenge. Finally, students should constantly aim for **synergy**, e.g. interdisciplinary collaboration on the complex challenge at hand should be more effective and rewarding for participating disciplines compared to going at it by themselves. To obtain a common goal and a common ground students should understand and appreciate the perspectives of students from other disciplines [3]. Fostering **interdisciplinary exchange** revolves around being able to relate their own disciplinary perspectives and matching motives and intentions to the motives and intentions of students that are grounded in/based on other disciplines.

Interdisciplinary exchange concerning the complex challenge thus is the core of the initial phase of an interdisciplinary project. Prior research [4] showed that students in the 3S struggle to exchange, utilize and integrate disciplinary knowledge. Therefore, the focus of this current research is to map if students were able to reach a common ground and attain synthesis during their 3S project.

2 METHODOLOGY

2.1 Context

This research project was executed during the 20/21 academic year. Two researchers (e.g. the first and third author) were involved in the data gathering. The research took place in the 3S, in which third- and fourth-year students of 22 bachelor programs collaborate in interdisciplinary project groups of 6-8 students (25 ECTS). Over a 1000 students and 100 tutors work and learn in this semester. During the semester students develop competencies in three domains: professional behaviour, application and development of research capabilities and application and development of knowledge and skills from their own and other disciplines. Each project group is supported by a tutor.

2.2 Research questions and design

The main focus of this research was identifying to what extent students are able to obtain a common ground through interdisciplinary exchange whilst working and learning in an interdisciplinary project group and to what extent they are able to reach synthesis. A learning activity (see 2.3) to foster interdisciplinary exchange was designed and conducted with four project-teams (see table 1 for their composition), five weeks after the start of the semester. This session took place online and was recorded. The four teams participated in a focus group which took place within two weeks after the learning activity. The focus group was partly semi-structured around the four processes crucial to interdisciplinary collaboration and partly based on questions concerning recorded chapters from the learning activity. The focus of the interview laid on both project-work leading up to the learning activity, as well as the learning activity itself. Furthermore an interview took place with the tutor of each group, leading to three interviews (one tutor was absent). This interview mimicked the semi-structured part of the focus group interview with students. Because of Corona-measures, all these interviews took place online via Teams.

Table 1. Composition of project-teams

Case	N	Disciplines
1	6	Nursing (4), Information and Communication Technology (1) and Creative Business (1).
2	8	Forensic Research (1), Civil Engineering (3), Archaeology (2) and Mechatronics (2)
3	7	Nursing (3), Industrial product design (1), Technical Informatics (1) and Creative Business (1)
4	6	Archaeology (2), Forensic Research (1), Technical Business Administration (1), Information and Communication Technology (1) and Creative Business (1).

2.3 Learning activity

The goal of the one-hour learning activity was fostering interdisciplinary exchange to reflect on if a common ground was attained. One researcher led the learning activity and the tutor was not present during the activity. The learning activity was based on the concept of triangular reflection [5] and revolved around three subsequent activities. Students were asked to complete a mindmap in which they both explained the added value of their own discipline for the challenge at hand and reflected on the added value of the other disciplines within the project group. The first phase was aimed at *exchanging* relevant disciplinary knowledge and skills from their own discipline. The second was aimed at *creating* the coherence between disciplines and the complex issue at hand. The final phase was aimed at *reflecting* on how to integrate interdisciplinary knowledge and skills throughout the further course of the project. The researchers challenged students to put under words their own perspective concerning the complex issue, but also explain how and why the other disciplines were of added value for solving the complex issue.

3   RESULTS

3.1 Common ground and synthesis

An analysis within and between cases was conducted focused on whether a common ground and synthesis was attained within the cases. A rubric for ranking interdisciplinary work [6] was used to determine the amount of interdisciplinarity in each group. Results showed that only one group was partly able to attain synthesis.

Several factors negatively affected the ability of students to reach synthesis. Firstly, the complex challenge was not truly an interdisciplinary challenge in three out of four cases and did not offer the possibility for interdisciplinary collaboration aimed at synthesis. Students noted they did not see the "match" between their own discipline and the challenge. In addition, students did not have the opportunity to decide the common goal for the project because in two out of four cases this goal was already set by the client. Furthermore, even if the challenge offered the opportunity for student goal-setting and synthesis, students often organized themselves multi-disciplinary by working with for instance only the nursing students on sub-tasks, since synergy was not necessary for solving the challenge. Finally, only one out of four project groups focused on interdisciplinary exchange prior to engaging in the learning activity and was able to reach some sort of common ground. Critical awareness thus was not fostered during working on the project. The 3S is the first time for most students to engage in interdisciplinary collaboration. Whereas students have no or limited interdisciplinary skills when enrolling in the semester, these need to be fostered in order for them to reach synthesis whilst working on complex challenges.

Support offered by the tutor on guiding students to attaining a common ground through interdisciplinary exchange differed between tutors. Mostly tutors mentioned the importance of getting to know each disciplinary background, but left it to students to take action on engaging in this dialogue. Results showed tutors focus mostly on supporting research activities of students and on personal introductions. Professional

(disciplinary) introductions and disciplinary orientation concerning the complex challenge received little attention by both students and tutors. Possibly tutors lack the insight in the importance of fostering interdisciplinary exchange, which led to them being passive on this matter.

3.2 The learning activity

Students from all four cases responded positively to engaging in the learning activity. The level of perceived impact of the learning activity differed based on the phase of interdisciplinary collaboration. When students had not yet engaged in any interdisciplinary exchange and working towards attaining a common goal and common ground, the learning activity made them aware of the importance of interdisciplinary exchange. When students already had engaged in interdisciplinary exchange prior to the learning activity, participating in the learning activity invited them to elaborate on their insights concerning the common goal and common ground. It led to confirmation of their own insights related to the insights of other group members.

3.3 Recommendations

This exploratory case study further strengthens insights concerning interdisciplinary collaboration. Although the number of cases was limited, combined with the prior research mentioned earlier [3], it is plausible that a larger number of students within the 3S and within higher education in a broader sense are unable to reach synthesis during interdisciplinary collaboration. Four recommendations are at the core of improving and fostering interdisciplinary collaboration in higher education when working on complex interdisciplinary challenges. First, to be able to collaborate interdisciplinary, it is important for students to be able to work on complex and **ill-defined challenges** where they truly have enough room and **autonomy to set or adjust the common goal**. This allows them to consider whether and by which means their discipline can be of added value for reaching synthesis. Second, to encourage interdisciplinary exchange, **learning activities** can play a crucial role, for example focused on **reflecting on disciplinary knowledge and skills** related to the complex challenge. Third, when guiding students during interdisciplinary collaboration, **tutors** play an important role in guiding students when working on complex challenges. By showing tutors the means through which they can foster interdisciplinary collaboration and offer them opportunities for practice, the impact on student learning should increase. Finally, when developing interdisciplinary education, it should be taken into account that this requires **complex skills which should be developed throughout the curriculum**. It is important that students are offered opportunities to get acquainted with interdisciplinarity early on in their studies. This allows them to realize and determine when interdisciplinarity is of added value and which processes are important to take into account when working on complex challenges across disciplinary boundaries.

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