Internal stakeholders’ views on interdisciplinarity: An empirical study within an interdisciplinary master’s program

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Abstract: Even though research exists on interdisciplinary education and interdisciplinaty skills, the term “interdisciplinary” is ambiguous. Currently, studies on how different internal stakeholders in an education setting define and conceptualise interdisciplinarity are lacking. Consequently, the purpose of this paper is to define and conceptualise interdisciplinarity in higher education. This is investigated by focus group interviews with 29 internal stakeholders representing students, teachers, and program managers at an interdisciplinary master's program. The conclusion provides a definition of interdisciplinarity; The integration of people possessing different competencies (knowledge, background, and skills) acting upon an identified need, challenge or opportunity that requires a holistic approach founded in synergies and thereby creating
new knowledge. Interdisciplinary learning is mainly conceptualised to take place in open-ended and research-like innovation projects.

Subjects: Higher Education Management; Study of Higher Education; Teaching & Learning

Keywords: Interdisciplinarity; focus group interviews; internal stakeholders; interdisciplinary higher education; innovation master’s program

1. Introduction

Today’s business environment is constantly changing, resulting in difficulties for students to choose and apply for an education that will meet the requirements of their forthcoming professional life. To accommodate higher education in the current business context, there is a need for universities to graduate students who can operate in changing environments (Delaney, Pattinson, McCarthy, & Beecham, 2017). Interdisciplinary knowledge will increase the students’ ability to understand complex challenges (Annan-Diab & Molinari, 2017). Consequently, there is an increased demand on universities and teaching institutions within higher education to teach interdisciplinarity to students. At the same time, the concept of interdisciplinarity acts as an enabler to challenge traditional teaching and thereby constitutes “an intellectual attitude” for project-oriented collaboration between scholars from different disciplines (Trommler, 1992).

Interdisciplinary knowledge will prepare students for their professional lives, as underscored in Newell (2012). Several universities and teaching institutions have developed interdisciplinary courses (see, for instance, Augsburg, 2003; Duffield, Olson & Kerzman, 2013), and they encourage interdisciplinary programs (Vanstone et al., 2013) to meet the needs of future employers. From a university perspective, the academic workplace is becoming increasingly complex for faculty members (O’Meara, Rivera, Kuvaeva, & Corrigan, 2017). Faculty members are, in general, committed to their work, and to offer a stable work life, universities and teaching institutions need to reduce complexity (Johnsrud & Rosser, 2002). Needless to say, this is a complicated balancing act—providing complexity in educational programs in the form of interdisciplinary learning, while not increasing the complexity of the work environment for involved faculty members.

It is important to identify ways to establish interdisciplinarity in the traditional university structure by teaching more than traditional industrial project setup (e.g. Tonnquist, 2016). The concept of interdisciplinarity is ambiguous, as it might imply different characteristics to different stakeholders. For unclear concepts, a definition of terms is useful (Govier, 2013). In the traditional university structure, two internal stakeholders are mainly involved; faculty members (faculty members teaching and/or acting as program managers) and students (Ramsden, 2003). It is important that internal stakeholders have the same view on issues to reach the most beneficial output in an efficient way.

For universities aiming to teach interdisciplinary programs/courses, a dilemma appears; striving to reduce complexity and at the same time imitate professional working life. The need to be able to employ students with interdisciplinary knowledge cannot be misunderstood. Currently, studies providing a state-of-the-art description of how interdisciplinarity is defined and conceptualised within traditional university structure are lacking. There might be explanations for this, but to realise and offer a well-developed program, a united holding amongst involved internal stakeholders is needed.

The main purpose of this paper is to discover characteristics of interdisciplinarity in higher education, and thereafter compare the findings with existing literature. Hence, the following questions arise: 1) How could interdisciplinarity be defined by different internal stakeholders? and 2) How could interdisciplinarity be conceptualised in an interdisciplinary master’s program?
2. Method and empirical setting

This paper deploys an inductive approach (Bryman & Bell, 2013), aiming at a deeper understanding of the concept of interdisciplinarity in higher education. Inductive research is useful when additional perspectives are needed for specific research (Eisenhardt, 1989). This is done by studying internal stakeholders' conceptualisation of interdisciplinarity in a master's program utilising the focus group interview method. Focus group interview is a recognised method for examining how respondents together interpret the general phenomenon the researcher is studying (Bryman & Bell, 2013). Further, focus groups are preferred, as they explore opinions, previous experience and future expectations (Rodrigues et al., 2010). O’Neill and Palmer (2004) claim that focus groups are appropriate, as they allow for gaining interesting insight into respondents’ mind-set. They are advantageous, as they allow for follow-up questions and clarifications (Bryman & Bell, 2013). Consequently, empirical data has been gathered through focus groups with open questions focusing on interdisciplinarity. Each focus group interview were recorded and thereafter transcribed, and included two up to six participants. The discussions were directed by two researchers, guaranteeing that no single participant was given too much speaking time, and that all participants were answering each question. The interview guides are presented in Appendix A. Appropriate members in a focus group are those who possess experience in the studied phenomenon (Bryman & Bell, 2013). In the present study, focus groups have been carried out with three categories of respondents (internal stakeholders); 1) students (fourth-semester students writing their thesis who were therefore able to reflect on their previous education), 2) teaching faculty members, and 3) faculty members acting as program managers. For information on each category of respondents (number of focus group/s, and total number of respondents) see Table 1. In total 29 respondents participated in the study.

The program involves students from three faculties; Faculty of Engineering, Faculty of Arts and Humanities, and School of Business and Economics, all enrolled in the same program. Students enrolled in the program ought to develop competencies in interdisciplinary teams and deepen their individual subject knowledge. The program is based on the students’ conducting realistic innovation projects based on briefs provided by different stakeholders outside the university. The program consists of four semesters, 30 credits each. The first year is interdisciplinary, whereas the second year consists of traditional advanced courses.

For analysing the interview results, conventional content analysis in which coding categories are derived directly from the interviews was applied (Hsieh & Shannon, 2005). In this conventional content analysis, the authors let the data “speak for itself” and selected phrases containing information relevant to the respective research question. The data analysis started with each author reading the empirical data repetitively to get a basic understanding and capture the core concepts. The empirical data were given codes. Labels for the codes emerged that reflected several codes or notion of codes. These labels were thereafter sorted into categories, as recommended by Hsieh and Shannon (2005). The extracted quotes and final categorisation are found in Appendixes B–D. Within conventional content analysis, relevant theories are addressed in the discussion section (Hsieh & Shannon, 2005).

Boily (2006) identified scientific criteria for qualitative research concerning credibility, transferability, dependability, and conformability. These have been obtained in this paper as follows:

| Respondent category                              | No. of focus group/s | Number of total respondents |
|--------------------------------------------------|----------------------|-----------------------------|
| Students                                         | 7                    | 16                          |
| Teaching faculty members                         | 2                    | 8                           |
| Faculty members acting as program managers       | 1                    | 3                           |

Boily (2006) identified scientific criteria for qualitative research concerning credibility, transferability, dependability, and conformability. These have been obtained in this paper as follows:
Credibility implies, for instance, authenticity, and plausibility of the results (Miles & Huberman, 1994). Credibility in this study has been achieved by applying appropriate methods, and the conclusion stems from the data as recommended by Lincoln and Guba (1985).

Transferability refers to the applicability of findings outside the research setting (Stake, 1995). Transferability allows for replication of the study in other settings, situations, and with other participants. A discussion of transferability regarding the research questions is presented in the conclusion chapter.

Dependability refers to internal consistency between research questions, data collection, and analysis. To enhance dependability, a detailed description of the research process is provided as recommended by Bailey (2006).

Conformability infers that the findings can be supported by data (Baily, 2006). The findings of this study are clearly supported by the empirical data.

3. Main findings
In this section, the main findings from the focus group interviews are described. Empirical material in the form of representative quotes and their categorization is found in Appendixes; student quotes are presented in Appendix B, teaching faculty members in Appendix C, and faculty members acting as program managers in Appendix D (each quote is identified by a number; the first number refers to the appendix number, while the second number is a serial number, serial number). In total, 10 different categories were extracted. Four categories describe the definition of interdisciplinarity: integration of people, Integration of knowledge, deepened knowledge as outcome, and problem-solving. Six categories describe the interdisciplinary conceptualisation: Student active learning, traditional learning, real-life setting, physical location, teacher role, and curriculum (interdisciplinary learning as seen in the curriculum). Table 2 accounts for the frequency of responses regarding each category.

The empirical data is organized according to the questions and the different internal stakeholder category.

| Categories in relation to each specific research question | Students (16 respondents) | Teaching faculty members (8 respondents) | Faculty members acting as program managers (3 respondents) |
|----------------------------------------------------------|---------------------------|----------------------------------------|----------------------------------------------------------|
| How could interdisciplinarity be defined by different internal stakeholders? | | | |
| Integration of people | 21 | 4 | 3 |
| Integration of knowledge | 8 | 8 | 2 |
| Deepened knowledge as outcome | 10 | 4 | 3 |
| Problem solving | 9 | 5 | 1 |
| How could interdisciplinarity be conceptualised in an interdisciplinary master’s program? | | | |
| Student active learning | 10 | 9 | 6 |
| Traditional learning | 4 | 2 | 1 |
| Real-life setting | 2 | 1 | 0 |
| Physical location | 3 | 1 | 2 |
| Teacher role | 2 | 6 | 4 |
| Curriculum | 2 | 4 | 2 |

*One from each involved faculty.
3.1. How could interdisciplinarity be defined by different internal stakeholders?

3.1.1. Students
The students commonly saw interdisciplinarity as the combination or integration of disciplines or students from different disciplines. Some students discussed the possibility to be an interdisciplinary student, if this student studies two or more disciplines (for quote, see for instance, serial number 2.2). The discussion was extended to include not only academic experience but also practical experience (for quote, see for instance, serial number 2.10). Although a majority of the students viewed interdisciplinarity as something happening between students, they reflected upon the necessity of having an exchange between students for creating interdisciplinarity. Otherwise, interdisciplinarity was perceived to remain as thoughts without action.

The action takes place between students, and several students saw interdisciplinarity as a way of working together. Students viewed the project work, in which participants from all three disciplines work together to solve a real-life problem stated by an external party, as the setting in which interdisciplinarity took place. A distinction between working as a group and working in an interdisciplinary setting was noted (for quote, see for instance, serial number 2.14).

Moreover, the students recognised that interdisciplinarity work has several purposes. The opportunity to learn from each other was recognised as one purpose. Another commonly discussed purpose was solving problems and creating new things. Several students found these two purposes as interlinked; by learning from each other, they will be able to reach the objectives. This is enabled only if students are open to new experiences and thoughts (for quote, see for instance, serial number 2.25).

As a student, you have to apply an open mind and a willingness to learn not only new knowledge but also work on your social competencies (for quote, see for instance, serial number 2.24).

Language was emphasised as something you learn from each other. By working in an interdisciplinary way, students learn terms and languages of the other disciplines. The learning is deep; you have to understand the meaning of a word rather than the single definition. One example that was brought up is the term “sketch,” which means quite different things for an engineer and a designer (for quote, see for instance, serial number 2.22). The interdisciplinary setting as a means for achieving a common goal is clearly seen in the previous quote, as well as the necessity to discuss and learn from each other. By collaborating and viewing the same problem from several perspectives, a deeper knowledge of the problem area (and its solutions) is gained.

3.1.2. Teaching faculty members
While the students focused on interdisciplinarity as something that happened between people, the teachers mainly focused the discussion on integrating disciplines, or disciplinary knowledge. One teacher explained that interdisciplinarity is represented in the versatile genius, i.e. a person who manages several disciplines, such as da Vinci. A classical industrial design project could also be seen as interdisciplinary. It is also seen in study programs combining two or more disciplines some teachers argued. The view was not unanimous, though (for quote, see for instance, serial number 3.3).

It was recognised that interdisciplinarity was a means to increase problem-solving capacity and a working method for reaching a common goal. The knowledge gained by interdisciplinary work is a synthesis, rather than separate disciplinary pieces, according to one teacher (for quote, see for instance, serial number 3.16). That kind of learning is quite complicated and unique in higher education, the teaching faculty member continued. The term interdisciplinarity was mainly discussed from the student perspective, but it was also recognised that interdisciplinarity could be a working method for teachers.
3.1.3. Faculty members acting as program managers
The interviewees agreed that interdisciplinarity could be viewed as different disciplines working together towards a common goal, sharing ideas and knowledge. The sharing is not one-way, but directed in both ways, one respondent explained. Respondents also recognised interdisciplinarity as a working method or a way to approach a problem. Working in an interdisciplinary mode strengthens one’s own disciplinary understanding (for quote, see for instance, serial number 4.5).

The different disciplines represent more than a specific knowledge base; they represent cultures with their own language and codes, which can be visible by working in an interdisciplinary setting. It is most important with interdisciplinary learning not to deepen your own knowledge but to understand the other disciplines’ codes, one program manager concluded.

3.2. How could interdisciplinarity be conceptualised in an interdisciplinary master’s program?
The respondents were asked to describe where and how interdisciplinarity takes place in the program. In addition, the teaching faculty members and faculty members acting as program managers reflected on their own teaching and which forms of teaching support disciplinary teaching and interdisciplinary teaching.

3.2.1. Students
Interdisciplinary learning happens mainly in the project work, according to the students. Interdisciplinarity is a way of working, and interdisciplinary learning is a result of discussions held within the project team (for quote, see for instance, serial number 2.37). The lectures were not seen as a means to learn interdisciplinarity; it happened in the projects (for quote, see for instance, serial number 2.42).

According to the students, interdisciplinary learning happens in a real-life context where a team consisting of different disciplinary abilities have to solve a problem or deal with an issue. The real-life context was not explicitly mentioned by many students when discussing where and when interdisciplinarity took place, but the projects were all real-life assignments by external stakeholders, and the connection with industry was seen as a driver for entering the program.

The students also mentioned the studio as a place in which interdisciplinary learning took place, and the interdisciplinary teachers’ team as a support for the learning. Just as interdisciplinarity was not seen as a topic of lectures, interdisciplinarity was not seen in the syllabi either (for quote, see for instance, serial number 2.47).

3.2.2. Teaching faculty members
Teaching faculty members also recognised interdisciplinary learning as something that happens in the projects. They stressed the interactivity and training of capabilities during the projects. The learning process is continuous and incremental over time (for quote, see for instance, serial number 3.18). The teachers also reflected on their role as tutors for enabling the interdisciplinarity (for quotes see for instance, serial number 3.21). Reflection was also given to the problems that arise in interdisciplinary education, and how they could improve the learning process for students, for instance, by better instructions and coordination. Students need to learn a new way of learning.

Different ways to view teaching were described. Some of the teaching faculty members did not see interdisciplinarity in the teaching, especially not in the lectures, while others saw tutoring as interdisciplinary teaching. One teacher argued that being strong in one’s own discipline is a prerequisite for being successful in interdisciplinary programs (for quote, see for instance, serial number 3.34).

The discussions also considered the way the program was regulated. Several teaching faculty members saw interdisciplinarity as a way to structure and organise a program and not a way of teaching (for quote, see for instance, serial numbers 3.32 and 3.36).
3.2.3. Faculty members acting as program managers

The faculty members acting as program managers held a more abstract discussion regarding interdisciplinarity and when it happens. Many thoughts were centred around the learning that happens in interaction with others (for quote, see for instance, serial numbers 4.10 and 4.15).

Learning as a continuous process that happens all the time, even during non-scheduled hours, was also reflected upon (for quote, see for instance, serial number 4.17). Teaching faculty members should work according to the interdisciplinary setting, but teaching is mainly disciplinal, according to the faculty members acting as program managers. Teachers should be good role models (for quote, see for instance, serial numbers 4.7 and 4.12).

The faculty members acting as program managers recognised interdisciplinarity as difficult for students, and if the balance between challenge and safety is poor, they tend to fall back to their own discipline (for quote, see for instance, serial number 4.14).

4. Discussion

4.1. How could interdisciplinarity be defined?

Definitions are useful for all concepts. There are four types of definitions: reportive (describes how a word is used), stipulative (refers to how a group uses a word), ostensive (aims to collect concepts directly to the world by identifications of examples), and persuasive (stipulative definitions concealed as either reportive definition or factual statements). The adequacy of a reportive definition can be evaluated based on the following criteria 1) essential features included, 2) scope (broad and narrow), 3) obscurity, and 4) circularity (Govier, 2013).

People working together in multidisciplinary groups resemble a traditional industrial project setup, where project outcomes can be reached without extensive collaboration between project team members; see e.g. Tonnquist (2016). In the studied master’s program, the students are working on projects, but the nature of these projects is quite different from traditional project work. The integration of different people possessing different knowledge is essential to solve the task given. Consequently, integration of people and knowledge become natural parts of the definition as well as the problem-solving.

As early as 1978, Meeth recognises the real-life context and the necessity to integrate disciplines. The latter characteristic is recognised by several authors (see for instance, Davies & Devlin, 2007; Porter, Roessner, Cohen, & Perreault, 2006; Rogers, Scaife, & Rizzo, 2005). Pharo et al. (2012) emphasise outcomes when integrating disciplines in the form of insights that are more than the sum of each discipline’s knowledge brought into the learning situation. To enable a broadening of knowledge, a deepening of knowledge must also take place, as it is only possible to discuss and adjust the details. Consequently, deepened knowledge as an outcome is an aspect to be considered in proposing a definition.

In 1990, Thompson Klein states that interdisciplinarity is just as difficult to explain as it is to apply in concrete situations. However, interdisciplinary work is common for those who work with knowledge production (Aram, 2004). Trommler (1992) claims that the concept of interdisciplinarity is an “intellectual attitude” that stems from challenging the traditional teaching setting. Interdisciplinarity holds different dimensions, including the integration of different methods and viewpoints (Davies & Devlin, 2010). Davies and Devlin (2010) propose the following definition of interdisciplinary learning; “integration of two or more disciplines in the education”, whereas Pharo et al. (2012) propose “the integration of disciplinary perspectives to produce insights that are more than the summing of disciplinary knowledge”. Several definitions have been provided. However, “integration of disciplines” and thereby facilitating the creation of deep knowledge (Pharo et al., 2012; Rogers et al., 2005) seems to be common. In 1978, Meeth provides the following definition; “Interdisciplinary programs attempt to integrate the contributions of several disciplines to a problem, issue, or theme from life …” Aldrich (2014) provides the following definition including research as well as teaching;
Interdisciplinary research (IDR) is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or field of research practice.

In interdisciplinary studies, integration means bringing interdependent parts of knowledge into a harmonious relationship. It involves relating part to part, part to whole, and whole to part. Porter et al. (2006) suggested the following definition; “a mode of research by teams or individuals that integrates perspectives/concepts/theories, and/or tools/techniques, and/or information/data from two or more bodies of specialized knowledge or research practice”.

The provided definitions offer common characteristics; integration of people and/or knowledge, deepened knowledge as an outcome, and problem-solving.

4.2. How could interdisciplinarity be conceptualised?

Interdisciplinary learning outcomes depend on, for instance, previous experience and language (Ryser, Halseth, & Thien, 2009). The students participating in this study recognised the importance of developing social competencies in addition to the knowledge-related competencies. A common workspace could serve as a key platform for developing knowledge-related and social competencies (Holley, 2015). Interdisciplinarity does not appear to be supported by traditional university layouts with lecture rooms and clearly separated locations for students and teachers. Instead, the students perceive a need for dedicated workshops for project work, preferably equipped with technical and physical resources supporting the development of solutions in all stages, from concept development and design to prototyping. Such resources could, for instance, be video-conferencing equipment, simulation software, manufacturing machines or 3D-printers. The project teams also perceive a need for a designated project work area, where the confidentiality of the project could be ensured. Closeness to teaching faculty members should be enabled as well. Since the teaching faculty members come from several subject areas, it could be impossible to arrange offices near the student workshop. Sufficient and relevant resources for the project teams in the form of physical locations, materials and tools are thus important.

Immaterial resources, such as support for learning in the form of lectures, tutoring and structured methodologies, are perceived to be of equal importance. Interdisciplinarity was perceived as something that happened in the project teams, often outside normal teaching hours. While this correlates well with the definition of interdisciplinary, there is fuzziness regarding where learning takes place. Learning could be seen as a process of reproduction or creating meaning (Ramsden, 2003). In disciplinary settings, reproduction is an effective way to learn the language, theoretical constructs and methods of the particular discipline. In interdisciplinary settings, creation of meaning is predominant, which implies finding the best theoretical constructs and methods for solving a specific problem.

5. Conclusions and further research

This research contributes to the body of knowledge as regards defining and conceptualising interdisciplinary programs/courses primarily by providing empirical data. This knowledge supports educational change, as it facilitates the development work of interdisciplinary programs/courses. Interdisciplinarity is becoming established as a subject in academia as compared to traditional subjects, and its characteristics are of vital importance. However, it is important to continuously stress the content of the concept. In this research, four characteristics of interdisciplinarity were identified; integration of people, integration of knowledge, deepened knowledge as outcome, and problem-solving. The following definition of interdisciplinarity is proposed by the authors of this paper:

The integration of people possessing different competencies (knowledge, background and skills) acting upon an identified need, challenge or opportunity that requires a holistic approach founded in synergies and thereby creating new knowledge.
This definition of interdisciplinarity could be categorized as a reportive definition. It meets assessment criteria proposed by Govier (2013), as it covers the integration of people and knowledge, as well as the context in which interdisciplinarity takes place, i.e. problem solving where the outcomes are more than the sum of the different disciplinary knowledge utilized, thus requiring a holistic approach. Deriving this definition is the first step in understanding how to create interdisciplinary learning.

This research further supports educational change as it pinpoints that interdisciplinarity is perceived through student active learning and real-life settings. The students participating in this study recognised the importance of developing social competencies in addition to the knowledge-related competencies. According to Holley (2015), fostering interdisciplinarity could be seen as a socialization process where faculty engagement and curriculum design are crucial factors for successful interdisciplinary programs. Thus, the interdisciplinary nature of the program should be visible in the curriculum and in the teaching. Interdisciplinarity was perceived by the students as something that happens intuitively in the program and by the faculty members as a way of working rather than intended knowledge content. The teaching faculty members recognised interdisciplinary teaching to take place mainly in tutoring sessions, i.e. in close connection to the project work, while lectures mainly focused on disciplinary knowledge. Whilst interdisciplinarity is best learned by practising, measures could be taken to strengthen the interdisciplinary work. Faculty members act as designers and enablers of interdisciplinary activities, on a strategic level by developing curricula, and on an operative level by activity creation and execution (Kans & Gustafsson, 2016). In an interdisciplinary setting, the teacher-centred approach in the form of lectures could focus on explaining interdisciplinary terminology, visualizing the interdisciplinary context, describing differences between disciplinary and interdisciplinary work, and proposing a methodology for students to use when working in an interdisciplinary mode.

In the curriculum, interdisciplinary knowledge contents, as well as modes of learning, should be highlighted. The study is inductive and based on focus group interviews. By nature, it is therefore connected to its setting; however, the results are connected to the concept of interdisciplinary, and the setting is of minor importance. Therefore, the results are transferrable to other settings.

To secure learning interdisciplinary knowledge, a working process needs to be established, securing focus on meeting students’ learning needs, while at the same time meeting the requirements stated in the respective course syllabi. This constitutes a basis for future research. This work still needs to be done. Another challenge for future work is to identify how to operationalize interdisciplinary knowledge. Further, there is a need to identify an evaluation model for interdisciplinary programs.

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Appendix A. Interview guides

Students

(1) How do you define interdisciplinary?

(2) What does interdisciplinarity mean for you?

(3) How does interdisciplinarity appear in the program?

(4) Where/how does interdisciplinary take place?

(5) Which stakeholders are involved?

(6) How do you define interdisciplinary?

Teaching faculty members and Faculty members acting as program manager

The definition of interdisciplinary

(1) How do you define interdisciplinary?

(2) What does interdisciplinarity mean for you?

Interdisciplinary in the program

(3) How does interdisciplinarity appear in the program?

(4) Where/how does interdisciplinary take place?

(5) Which stakeholders are involved?

Teaching interdisciplinary

(6) In the program, do you mainly do disciplinary or interdisciplinary teaching? (Why/why not?)

(7) How could interdisciplinary be thought?

(8) Which forms of teaching supports disciplinary teaching and interdisciplinary teaching?

Interdisciplinary learning environments

(9) What possibilities and hinders are there for you as a teacher/researcher participating in the program?

(10) How do you perceive the structural changes that occurred in the program from it started?

(11) How do you define interdisciplinary?
### Appendix B. Extracted quotes and the final categorisation—Results from student interviews

| Serial number | Quotes regarding definitions                                                                                                                                                                                                                                                                                                                                                     | Classification |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 2.1.          | People from different backgrounds, not just culturally but mainly also regarding the field of, I call it educational background that they have when they come together and work together                                                                                                                                                                                                 | 1               |
| 2.2.          | Interdisciplinarity could also be combined in one person when you ... in Germany you have the, also university programs called business engineering where you have two different fields of education that are combined in one program. So people who study business engineering they somehow are ... they combine the interdisciplinarity in one person.                                                                                          | 2               |
| 2.3.          | being influenced by different cultural as well as educational fields of interests when it all comes together                                                                                                                                                                                                                                                                   | 3               |
| 2.4.          | My view is also somehow steered by the program that I'm in that calls itself an interdisciplinary master program because we are students from business, engineering and design. So interdisciplinarity in that regard means what educational background that you have, the main field of study you had before, so that somehow influence on how I see an interdisciplinary now. | 2               |
| 2.5.          | Interdisciplinary work is easy: that is when the people from different disciplines meet each other, and interdisciplinarity itself can be, probably it always has to do with people meeting each other                                                                                                                                                                                               | 1               |
| 2.6.          | Does it have to be like two major directions, like business and engineering, or could it be like different directions within business like marketing discipline, finance discipline                                                                                                                                                                                                  | 2               |
| 2.7.          | Say like in one field, even in one team that work that work in a company, and the team is very specialized then there is still interdisciplinarity because people have different backgrounds, different things done before, or ... So you can probably go from very broad view and then you can narrow it down and go very much in detail and call it interdisciplinary                                                                                                    | 1               |
| 2.8.          | You really need some further explanation or definition when you say interdisciplinarity. ... is it maybe on the personal, one person as you said or is it like a team                                                                                                                                                                                                                         | 2, 1            |
| 2.9.          | A person can still on one topic from different perspectives but still be interdisciplinary. Yes, and that is what you said with business engineering. That one person can be a business engineer.                                                                                                                                                                                   | 2               |
| 2.10.         | I mean you can kind of randomly mix perspectives and say it is interdisciplinary and ... Because you also, it makes difference, you can have a general business background in your studies but that you might have practical experience from something, or. Then it is also kind of interdisciplinary, also that kind of knowledge you require through what you do every day.                                                                 | 2               |
| 2.11.         | You can have interdisciplinary thoughts for yourself but that is still ... What is interesting most of the time is the interdisciplinary work that people do with each other from different perspectives.                                                                                                                                                                | 1, 2            |
| 2.12.         | It involves a lot of disciplines working together, so I would say that it is collaboration with different people from different backgrounds with a positive outcome.                                                                                                                                                                                             | 1, 2, 4         |
| 2.13.         | It is different people working together for achieving one piece of work, we were linked to each other                                                                                                                                                                                                                                                                             | 1, 4            |
| 2.14.         | I think we need to differentiate between working interdisciplinary and interdisciplinary work, because I think that it is different when people from different disciplines come together and work together and connect their qualities and they learn from each other. It is not next to each other but with each other. Interdisciplinarity is when we link and make the best out of it.                                                  | 1, 4            |
| 2.15.         | Interdisciplinarity is more like people work together and learn from each other. The knowledge they learn might be in their discipline and they provide that knowledge to the rest of the group. It is two directions.                                                                                                                                                | 1, 3            |

(Continued)
| 2.16. | It is like people from different background work together in a group solving complex problems with their knowledge. The involved people in the group are willing to accept the other members’ suggestions and that is a mutual agreement between the members, finally they come for a solution to the whole project. | 1, 4 |
| 2.17. | It is not about understanding the word, it is about understanding the meaning. One word have several meanings, for instance, the word sketch | 3 |
| 2.18. | When people or citizens, from different backgrounds also different nationalities, come together to accomplish a goal or a project. Interdisciplinarity is when people from different backgrounds come together | 1, 4 |
| 2.19. | This diverse group working together, still, engineers and designers, interdisciplinarity is still beyond that, there are different types of people in life there are when 3, 4, 5 people with differences work together | 1 |
| 2.20. | Interdisciplinarity is cross functional, it means that people who have different experiences come together and work to achieve a common goal | 1, 4 |
| 2.21. | All the language and terms. What I see that each discipline has its unique language. | 3 |
| 2.22. | I can’t explain it as working together as it is beyond it. Working with different perspectives on the same goal. Work in process with other disciplines towards the same goal, but also conversation. We had a project in Poland, A., M., Z. and me. In a car to Poland we discussed the project. Should have recorded the conversation, because we could approach from different angles the same project, understand weaknesses and strengths. | 1, 3, 4 |
| 2.23. | It’s about working together with an open mind. To ... because to work together you need to be open, to learn from each other. | 1, 3 |
| 2.24. | Interdisciplinary work not just have to have three people different people together, it has to have the right attitude and the right environment to work. | 3 |
| 2.25. | It’s me including and involving the engineer and business to learn about design and help me take the decisions. I cannot make them by myself even if I’m the designer. | 1, 3, 4 |
| 2.26. | Interested in your own discipline and be able to define your problems within the project, your own disciplinary problems to each other and communicate to each other what we need from each other in different disciplines. | 1 |
| 2.27. | Working closely with students partly from other institutions (marketing —accounting) but also other faculties (design and engineering)/ academic groups | 1 |
| 2.28. | Combination of disciplines (which depend on the type of project) | 1, 4 |
| 2.29. | It is a situation being in an interdisciplinary team, understand the other members, more useful comments to the other members. The other members can understand why you ask specific questions. | 1, 3 |
| 2.30. | You become interdisciplinar only by working with others | 1 |
| 2.31. | Understand what it means—only by cooperation and solving conflicts, personality, nationality—cooperate and communicate differently Based on working in teams, we have learned ... not the directly academic | 3 |

Quotes regarding conceptualization

(Continued)
### Appendix B. (Continued)

| 2.32. | In the projects. In the projects that we worked on together. Because we didn't have that many lectures, and if we had lectures then they were either based on some business topics or some engineering topics. | 5, 6 |
| 2.33. | Yeah, it was not like a professor comes in now, this is what interdisciplinarity is about and lists all the things you have to look at. It was more you get thrown into projects and there it is a number of designers, a number of engineers, number of business people and then you have the issue you are dealing with and then you start and make through all the mess that arises you learn how to deal with it. | 6, 5 |
| 2.34. | In reality it works in the production line, the program is in connection with the real world and how people work | 7 |
| 2.35. | It is in the projects; I have an example when working with IKEA-module. I designed a really nice thing and the engineer said that we cannot do it is a sustainable material, and I said; what do you mean? | 5 |
| 2.36. | Designer almost always have innovative ideas but sometimes it is not easy to make it reality, I think this program is more to drag the designers’ imagination back a bit into reality. the box is not that limited—it is more to do the things reachable.—we have to think about the concept. | 7 |
| 2.37. | When we work in interdisciplinary teams, we complement each other. | 5 |
| 2.38. | Based on my own experience, in the first year, in the first semester we all learnt how to work in an interdisciplinary team - we needed time to work in this adopted mode, sometimes mistakes happened. For the second semester, we could always add something on it based on our aspects; designers—crazy ideas, business people—how to make it work, and engineers—we calculate if it could work or not. | 5 |
| 2.39. | In our studio. Everyone came and we had our roles,,,,, we usually had lunch together in the restaurant and we talked about the projects, but mainly in our studio. | 8 |
| 2.40. | We showed our projects before the final presentation and we got valuable feedback from different teachers from business, engineering and design, it was very valuable for us to progress in our projects. | 9 |
| 2.41. | All teachers had their own subject into the project, design teachers focused more on design, engineering focused on finding a solution, business people were dominant. Some teachers had a strategic focus | 9 |
| 2.42. | It is important to discuss together with friends. Interdisciplinary working in some hands on projects but in theoretical background, I do not know which lecture was about interdisciplinary work? There were good lectures in different disciplines. | 5, 6 |
| 2.43. | That project, and, it was not in the classroom, it was when we would meet with our group and discuss and sometimes had some arguments and sometimes, but we … because we believed in what we believed, so we had arguments … then you also felt ok if we on our own together business, engineers and designers, to kind of learn how to do it. It was very good, I think. | 5, 8 |
| 2.44. | So I think the learning is the discussions when you meet your group. | 5 |
| 2.45. | The way we were working [in the projects] | 5 |
| 2.46. | Interdisciplinarity is not directly shown in the course sylabi | 6, 10 |
| 2.47. | Interdisciplinarity is the way we are working in order to meet the targets in the course sylabi | 5, 10 |
| 2.48. | The studio was an important working place in semester one and two. You checked the studio every day. Semester 3 was different—it was boring, it was only course, it was only courses, but it was boring | 8 |

*Classification codes: 1) Integration of people, 2) Integration of knowledge, 3) Deepened knowledge as outcome, 4) Problem solving, 5) Student active learning, 6) Traditional learning, 7) Real-life setting, 8) Physical location, 9) Teacher role, 10) Curriculum.*
## Appendix C. Extracted quotes and the final categorisation—Results from Teaching faculty members interviews

| Serial number | Quotes regarding definitions                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Classification* |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| 3.1           | Different disciplines going between the different disciplines to see what can be seen on a common platform perhaps also keeping the specialties in the different disciplines—because you do not want to lose the essence of the involved disciplines.                                                                                                                                                                                                                                  | 2                |
| 3.2           | I can also see that the word as such (interdisciplinarity) is quite an academic word, but it is about learning and working between different disciplines                                                                                                                                                                                                                                                                                                                                 | 2                |
| 3.3           | In different disciplines they talk about generalists, that is people who can a lot of everything in that discipline so that they can have a broader picture, they are chief in design or whatever engineering. There are some “universalgeni” in Swedish like da Vinci, they were really interdisciplinary. In a modern way we have talked about this a lot.                                                                                                                                                                                                 | 2                |
| 3.4           | You have the different disciplines and what is really between them. It compares ... I think that there is a difference between which disciplines we are talking about, how much space there are between them (the disciplines). There are reasons why these disciplines are involved in this specific program                                                                                                                                                                                                                     | 2                |
| 3.5           | The new things that are developing, innovations, are between disciplines                                                                                                                                                                                                                                                                                                                                                                                                                     | 3, 4             |
| 3.6           | If we look at the innovation master it is like a classic industrial design project, a good designer has a large knowledge of engineering and smaller knowledge about economy. You have all ingredients.                                                                                                                                                                                                                                                                                                                  | 1, 4             |
| 3.7           | In an operational level confusion, but creative for learners, teachers. It is a scope where teachers become learners “we are learning a lot of this along with the students”. It is a journey.                                                                                                                                                                                                                                                                                                                             | 3                |
| 3.8           | If we compare with multidisciplinary it is still that you still have the disciplines separated in some way but you make them meet                                                                                                                                                                                                                                                                                                                                                              | 1                |
| 3.9           | I agree with you about business people having this background—a lot of engineering students come to business. On a higher education level it differs on between the counties in India,... business is a new area—design is traditional                                                                                                                                                                                                                                                                                   | 2                |
| 3.10          | MBA is just a thing coming from the states                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2                |
| 3.11          | In the meeting between the different students and how they from the start speak different languages and then they slowly understand that they talk about the same thing in different way.                                                                                                                                                                                                                                                                                          | 1                |
| 3.12          | That is also an interesting point sometimes designers think that they are the ones to generate ideas, but generate ideas are much more complex. Everyone can generate ideas. Everyone in this program have the possibility to [say] what is good in a design                                                                                                                                                                                                                                               | 4                |
| 3.13          | When people from different disciplines work together in a course, when the students on a course meet different disciplines connected to a question. You are working on a shared examination assignment                                                                                                                                                                                                                                                                                         | 1, 4             |
| 3.14          | When several disciplines meet in order to deliver towards one goal, but I would like to add that the synchronized subjects meet in order to deliver towards one shared goal.                                                                                                                                                                                                                                                                                                                               | 2, 4             |
| 3.15          | Two types of interdisciplinarity; one concerns very much progression in a subject i.e. management accounting, finance, for instance, ... you can teach in this manner ... these are common for the subject. Another what we perceive as extraterrestrial activities [Authors comment: not within the subject] like design, cooperation ... The strength is when we let these feed on each other, create synergies                                                                                                                     | 2, 3             |
| 3.16          | Interdisciplinarity is synthesis- instead of breaking down into pieces, you see the whole picture. Students learn to think synthetically—see whole things instead of parts, it is unusual and difficult                                                                                                                                                                                                                                                                                     | 3                |

(Continued)
### Appendix C. (Continued)

| Quotes regarding conceptualization |
|------------------------------------|
| 3.17. In the meeting between the different students and how they from the start speak different languages and then they slowly understand that they talk about the same thing in different way. | 5 |
| 3.18. When they do their projects and present, actual the process as such. There is a big differences when they have done it some time, I really like when they do it the third time—you have different language and different way of keeping up the work. | 5 |
| 3.19. L: what you can see in the presentations, when they present in the beginning you can really hear the they speak their own language J: That is an aspect we did not fully understand when we started the program—these cultural aspects need to be taken into consideration L: then also the language barrier,,, G: language depending on where you come from S: Specific for this program as we have so many international students and cultural backgrounds then the projects are really important because then they work, when you work you can see and feel, then they take in the knowledge in other ways than words | 5 |
| 3.20. L: In the projects J: that is where they train their capabilities G: That is where the interdisciplinarity shows up—where you have to solve the task/complex issue with all three disciplines | 5 |
| 3.21. The quality of interdisciplinarity—as it takes place everywhere—but in the beginning of the program, we as the teachers need to push the ideas to the students that it will be of value to them because they do not understand that. Once they have run a particular project, they realize what they have done and understand the uniqueness of the learning process. But if the student group is not able to understand or except the value interdisciplinarity is going to give them, the projects will fall out. | 9, 5 |
| 3.22. For tutoring mainly interdisciplinary, I have to solve many things for the engineering students. When I tutor and discuss with them it is mainly design and engineering, but even business, for me this is classic design work. Business is on on an overall level. | 9, 5 |
| 3.23. Teaching is on an overall level/conceptual level, It is in business, I do not think we have interdisciplinary teaching—the learning is interdisciplinary but not the teaching, maybe engineering does? | 6 |
| 3.24. teaching is disciplinary with the purpose that other should understand i.e. being helped by this knowledge for instance, what could you read out from a cad-drawing? | 6 |
| 3.25. To be a good generalist takes a life time, you are peaking when you are 60. We want to do it in 4–5 years is it possible? The education should be as a small company, with facilities, class room, and work shops | 7 |
| 3.26. Physical meeting place | 8 |
| 3.27. J: interdisciplinary does it require between some? The disciplinary you can do by yourself G: yes, it is difficult to be interdisciplinary by yourself. J: At the same time, you may need to reflect on the interdisciplinary for yourself | 5 |
| 3.28. It begins with the faculty members having a common understanding of the context and the delivery. We constantly underestimate to explain the context for the students. We as faculty members, we think we deliver a coordinated lectures to the students, but students see individual lectures. We need to be more interactive in our way of communicating our message and knowledge. Students are learnt to focus on silo activity. | 9, 10 |
| 3.29. It is apparent to 100% through project work. Students are forced to integrate in the projects | 5 |
| 3.30. When they interact, the synthesis appear in the projects | 5 |

(Continued)
| 3.31. | How we have organized the grouping. Faculty members will always be disciplinary, we do not have time to be 100-% coordinated. Resources do not cover that. | 9 |
| 3.32. | How are we going to manage the succession? The actual things that controls are: syllabus, group assignments etc.—these are fixed—they cannot be exchanged, we are going to be satisfied with the base level. It is the structure [that] creates interdisciplinarity. | 10 |
| 3.33. | Interdisciplinarity is a competence that is learnt [as a teacher] | 9 |
| 3.34. | You must be more skilled in your discipline when you are working in an interdisciplinary program, especially if you work with stakeholders; how do you contribute? If you do not, you can be replaced! It’s contradictory to “jack of all trades”. You must be skilled in your discipline in order to make a contribution in an interdisciplinary context. You have to motivate why you should be involved | 9 |
| 3.35. | Interdisciplinarity is a fiction, an idealized figure of a reality that may not exist. It is the form, the communication, the format that creates interdisciplinarity. | 10 |
| 3.36. | Our way of creating deliveries at universities is disciplinary. Interdisciplinary is rather a way of delivering an education rather than teaching. | 10 |

*Classification codes: 1) Integration of people, 2) Integration of knowledge, 3) Deepened knowledge as outcome, 4) Problem solving, 5) Student active learning, 6) Traditional learning, 7) Real-life setting, 8) Physical location, 9) Teacher role, 10) Curriculum.*
### Appendix D. Extracted quotes and the final categorisation—Results from Faculty members acting as program manager interviews

| Serial number | Quotes regarding definitions | Classification |
|---------------|------------------------------|----------------|
| 4.1.          | An exchange is understood between different disciplines, and an exchange in the sense that it is not one-way, but directed in both directions | 2, 3 |
| 4.2.          | Interdisciplinarity is a way of working | 1 |
| 4.3.          | Knowledge is exchanged between different disciplines | 2 |
| 4.4.          | To work from different disciplines towards a common goal | 1, 4 |
| 4.5.          | This means that you see new disciplines, which you might have little idea about. You know some concepts that you can relate to, so you do not feel so confused, it’s not completely new, and then you start to look at yourself, your own discipline. And then it becomes “Aha!” Then you are both confirmed by this discussion, that socializing is also important. | 3, 1 |
| 4.6.          | ... that you start to separate yourself, you begin to see yourself in your own thinking. Separating the different disciplines. In this case three different. You see their own role as well as what you can perform and (identify) the limits; what you can do and what you cannot do. What to do, what you should not do and then start connecting the disciplines. So when you start to see the boundaries between them it is then you can start over bridging them. That is cooperation, the right cooperation and you can win something on it | 3, 1 |
| 4.7.          | ... if you look at a discipline, that’s a way of being. You are in it, it’s not just knowledge, it is a way of being. You have codes, but then, the interdisciplinary opens up for other ways to be and other codes that you do not have to master completely, one must understand them. Especially when you go inside and solve things together. But I think that’s a good description. | 3 |

#### Quotes regarding conceptualization

| Serial number | Quotes regarding conceptualization | Classification |
|---------------|-----------------------------------|----------------|
| 4.8.          | It is a word that we use repeatedly in our program, both in marketing and in, yes, and when we present the program for the students. And when we teach. That’s something that we bring up all the time, really. | 10 |
| 4.9.          | We just started it. We picked up a group from different disciplines to solve something together. And then we’ve been working very hard to bring about a situation where they almost have to deal with this, huh. And then we were like, “What’s up, then?” We were not so prepared. We did not at all prepare ourselves in terms and methods, etc., but we moved on like this. | 9, 10 |
| 4.10.         | ... it’s up to this to find a distinction, “Yes, who am I in relation to you. You’re one of those and I’m one of those.” Like, that’s the first thing to happen. But then when they do, when we force them, they aim at a common goal, then things are happening in the classroom. This focus is an important part. What unites is the focus. Everybody wants be somewhere, everyone we give their best, I think. | 5 |
| 4.11.         | To me it is that we represent it through our teachers | 9 |
| 4.12.         | I think it is important that, yes, there is a desire that we also work as we expect them to work. There is a dialogue there, amongst the teachers. | 9 |
| 4.13.         | ... The intention has been to shape activities where everyone enter from their own perspective and discuss it. And from that discussion there will then be something common uniting the participants. From the different perspectives. It has been the intention so that it ... workshops and activities, yes activities. | 5 |

(Continued)
4.14. ... how sometimes it does not occur when we expect it to. I think that it might be interesting when you see that students have been trying for a while, working together in projects with different skills, but then they may face too much resistance and fall back to their own disciplines and then stay there. Because they are safer there, they may know what they are going to do and they cannot really take in more from outside.

4.15. It’s one thing to work in their competence to solve a certain task and the other to work with team dynamics to ensure that these competencies really flourish in the activities.

4.16. In the physical room, that is, this studio we have given them. A residence ... to have a residence that they feel “there I can be, that’s my place”. ... it combines technology and design, the bodily and that it is linked to a certain environment, the workshops are also the environment where things happen. Yield. And unlike our business administrators who have their world in the books in a way.

4.17. And then to hang out. To hang out constantly in that office. I think that happens a lot more when we’re not there ...

4.18. I: When you are in a classroom, what kind of teaching do you do that is interdisciplinary?
   P: I actually do quite a bit of disciplinary work. I have one ...
   M: Our methodology course is example. Like there, three representatives participate and deliver perspectives, and there is a community there.

4.19. Interdisciplinarity is not like a knowledge, it is a way of being.

Classification codes: 1) Integration of people, 2) Integration of knowledge, 3) Deepened knowledge as outcome, 4) Problem solving, 5) Student active learning, 6) Traditional learning, 7) Real-life setting, 8) Physical location, 9) Teacher role, 10) Curriculum.
