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Designing for productive feedback: An analysis of two undergraduate courses in biology and engineering

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Abstract

In the wake of a growing emphasis on students taking a more central role in shaping their own learning, it has become increasingly important that course designs cater for productive feedback. This study explores how feedback opportunities were incorporated into two course designs that in different ways aimed at engaging students actively in knowledge construction, and what might have contributed to making feedback in those contexts productive. A thematic analysis of course documents and interviews with teachers and students reveals that both courses included productive feedback opportunities. These were generated by arranging task and responsibilities in such ways that students could make use of feedback in their immediate work and their future learning. Our findings suggest that planning for productive feedback entails more than generating good feedback comments. Instead, teachers should view feedback as integral to their course designs and consider the practices of their disciplines during the planning process.

Keywords:

Feedback; Higher Education; Instructional design; Student experience

Introduction

Studies have shown that feedback on students' work is crucial for learning in higher education (Evans 2013; Hattie and Timperley 2007), but that the planning of productive feedback is challenging for many teachers (Bailey and Garner 2010). The purpose of *productive feedback* is to support student learning in the immediate course context, while also preparing 'students to learn prospectively, in their lives and careers beyond graduation' (Hounsell 2007, 103). This requires that students take an active role by seeking, negotiating and making use of feedback in their learning (Boud and Molloy 2013; Esterhazy and Damşa 2017).

This growing emphasis on students taking a more central role in shaping their own learning means that teachers must plan for *feedback opportunities* in which students can engage actively with and make use of feedback. This planning requires that teachers do more than merely providing written comments on student work. If productive feedback is to be a collaborative achievement of both teachers and students, then educators must create opportunities for students to enter into dialogues with their teachers and peers, and access resources that will support their understanding (Nicol 2010; Tuck 2012; Xu and Carless 2017). Doing so requires that teachers are aware of the challenges students

may face during feedback situations, and consider how courses might be designed in order to allow students to take more active roles in the feedback process (Carless et al. 2011).

While course designs that cater for productive feedback are often seen as beneficial to student learning (Boud and Molloy 2013), little empirical research to date has examined feedback as an integral part of course design. Instead, researchers have primarily studied feedback as an isolated event in which teachers transfer their knowledge to the students; and which depends on the quality and delivery of the teachers' comments (Evans 2013; Jonsson 2012; Winstone et al. 2017). Moreover, few studies have investigated how teachers' approaches to feedback are influenced by the specific disciplinary context, which influences the professional and educational practices and discourses with which teachers are familiar (Esterhazy 2018b; Trowler 2012; Yang and Carless 2013). We argue that the way designs cater for productive feedback should not be thought of as a prescribed, generic model or solution across disciplines but as a phenomenon that needs to be studied in the context of the respective discipline.

In this study, we explore how course designs from different disciplines incorporate feedback opportunities that support students in making use of feedback, both in the immediate course context and in their future learning. We ask the following questions:

(1) How are feedback opportunities incorporated in course designs?
(2) How do students experience the feedback opportunities as productive for their learning?

To address these questions, we employ a case study design using data from two undergraduate courses in Norway: a portfolio-based course in biology and a project-based course in software engineering. Feedback was a central element of both course designs, which otherwise differed in their organization of teaching and learning activities. These differences allow for an examination of those aspects that influence the ways in which designs in different educational settings incorporate productive feedback opportunities and how students experience these.

Empirical studies on feedback as part of design

While a number of studies have provided insights into different aspects that are important for understanding teachers' approaches to planning for feedback, research on the way feedback is incorporated into course designs remains scarce. Several studies support the 'relational' view of feedback as being situated in, and made possible through, a set of practices that constitute the disciplinary course environment. Among the first to take this approach was Mutch's (2003) study of teachers' written feedback comments, which argued that feedback is not an individual event a teacher performs. Rather, it should be seen as a practice that relies on both teachers' and students' actions and the ways these are informed by the local environment. Mutch also highlighted the importance of incorporating feedback into course designs and of providing students with opportunities to reflect on how feedback relates to knowledge in their discipline. Tuck (2012) later picked up on the idea of feedback as a practice in her study of teachers' experiences of providing feedback. Based on interviews and observations of teachers while generating comments, the author found that teachers generally considered their feedback practices to entail a range of activities such as reading, writing, internet searching, and having discussions with colleagues.

Following this line of argument, we may view the incorporation of feedback opportunities into course designs as essential to teachers' feedback practices. This idea is supported by Carless et al.'s (2011) interview study, which explored the feedback practices of teachers rewarded for teaching excellence. The teachers' feedback practices were characterized by several design-related aspects, including the use of dialogic feedback, technological support, and two-stage assignments that allowed

students to use feedback to improve their work. The authors concluded that good teachers develop productive feedback practices by planning 'dialogical processes and activities which can support and inform the student on the current task, whilst also developing the ability to self-regulate performance on future tasks' (Carless et al. 2011, 397).

Focusing on practices also highlights the importance of the teachers' understandings and interpretations of the complex environment in which planning for feedback takes place. Drawing on interviews with forty-eight teachers about their lived reality of feedback, Bailey and Garner (2010) found that teachers had difficulty finding a balance between their own intentions, their students' learning needs, and the wider institutional policies they had to abide by. Any design decision was therefore related to the way teachers made sense of their 'conceptions of the purpose of feedback, their pedagogical intentions and the requirements of the system' (Bailey and Garner 2010, 195). Xu and Carless's (2017) recent study on the orchestration of feedback processes by one university teacher also highlighted the close relations between teachers' understanding of feedback and the way they incorporate feedback in their course designs. Using classroom observations and interviews, the authors showed that the teacher had a certain understanding of feedback that influenced the way she arranged the different elements in her course in order to enable her students to engage with and learn from feedback.

The reviewed studies have made important contributions to our understanding of teachers' approaches to planning for feedback. However, most studies have focused only on teachers' experiences of the planning process. Few researchers have paid attention to the actual course designs that are created when teachers arrange tasks and responsibilities to generate specific feedback opportunities. Similarly, few have addressed how students experience the feedback opportunities that are generated by these different arrangements. To that end, this paper takes an empirical focus on the course designs in which teachers' ideas about productive feedback are materialized, and on how students experience the feedback opportunities as productive for their learning.

Conceptual departure points

In order to conceptualize the way in which feedback opportunities are integrated in and experienced as part of course designs, this study adopts a sociocultural perspective on activity and learning (Säljö 2009; Wertsch 1998). This perspective highlights the dynamic interdependencies between humans, their activities and material resources, and how these relations are socially constituted and evolve over time. Cultural tools are crucial to these processes, as they mediate knowledge, social conventions and ways of knowing in a given community of expertise (Wertsch 1998). In the context of teaching and learning activities in higher education, material and intellectual tools mediate educational conventions as well as discipline-specific knowledge and practices, all of which are consequential to student learning (Trowler 2012).

From this perspective, *course designs* are the products of teachers' planning and development work; they reflect the teaching/learning practices and discourses that teachers are familiar with (Goodyear 2015). In creating course designs, teachers activate experiences, knowledge, and standards from the knowledge domain by using tools and models for pedagogical practices. Course designs thus incorporate the established knowledge content and practices of the particular discipline. The resulting course documents (e.g. course plans, task descriptions) can be thought of as material instantiations of the teachers' ideas and decisions regarding the organization of tasks, activities, and responsibilities (Goodyear 2015). Feedback may be explicitly incorporated into the design, but it may also manifest itself more indirectly through the way in which teaching and learning are planned for.

How feedback is realized and experienced depends both on features of the planned course design and how this is enacted by teachers and students. Boud and Molloy (2013) suggest that course designs that support productive feedback should include multiple well-designed and sequenced tasks, which provide opportunities for progressive knowledge construction, repeated use of feedback, and practice how to provide and make use of feedback. As tasks and knowledge resources take discipline-specific forms, designs based on these principles are likely to take different forms in different disciplinary contexts. In general terms, however, we consider feedback as 'productive' when it provides students with opportunities to (1) make meaning of the information about the quality of their performance in the immediate course context and (2) develop skills that will allow them to capitalize on similar learning opportunities in the future.

In the analysis that follows, we use the concept of *feedback opportunities* to refer to those potential encounters incorporated within course designs in which students might seek, generate, or make use of information about the quality of their work (Boud and Molloy 2013). From a sociocultural perspective, an empirical examination of feedback opportunities within course designs requires analytical attention to the epistemic, material, and social relations that are envisioned in the designs. These relations include the ways in which knowledge and activities are organized for learning, the types of tools (e.g. texts, models) the teacher envisions students to work with, the planned forms of participation and social interaction in the course, and the types of responsibilities placed on teachers and students. These components and practices that can be planned for and organized are *elements* of the course design (Goodyear 2015). The way in which productive feedback is incorporated in course designs thus becomes visible in the ways these elements are arranged in the course documents, in the teachers' reflections on the relational organization and design choices, as well as in the students' experiences with this design.

Methods

Case study design

This study uses data from two courses examined within a larger research project on quality in Norwegian higher education[1]: a biology course and a software engineering course. Both cases were one-semester undergraduate courses at two higher education institutions in Norway that differed in both disciplinary context (biology and software engineering) and their pedagogical approach (project-based and portfolio-based, respectively). Rather than pursuing a comparative analysis, we used the cases as contrasting examples of how productive feedback is incorporated within course designs in different disciplines. The cases were selected for their emphasis on engaging students actively in knowledge construction, developing students' skills necessary for seeking and making use of feedback, and using tasks spanning the entire course period.

Data

The primary data includes a total of 60 pages of course documents and interviews with teachers and students. The two teachers were interviewed at the beginning of the semester to gather information about their intentions, aims and activities planned for their courses. Both teachers were interviewed again at the end of the semester focusing on their experiences with the course and how it was carried out, as well as their retrospective justifications for the different course arrangements. Students were

[1] For more information see Damşa (2018), Esterhazy (2018a), and www.qnhe.no.

interviewed about their experiences with the course activities. Based on the different course sizes, we interviewed three student triads in the biology course (total N=9) and five triads in the software engineering course (total N=15). All interviews were recorded and transcribed verbatim producing a total of 316 pages of text.

Supplementary data included observations of teaching and learning activities and data from the learning management systems (LMSs) used in the courses. Analyses of how students and teachers engaged in various course activities are reported in previous publications (Esterhazy 2018a; Esterhazy and Damşa 2019). In this article, we take the course design as our focus of analysis and use the documents and interviews to analyse the way feedback opportunities are incorporated into the designs, how teachers justified their decisions and how students experienced the resulting feedback opportunities.

Course contexts

The biology case is based on a twenty-one-week-long undergraduate course in ecology within the bachelor's degree biology programme at a research-intensive university in Norway (see Table 1). The course, which included twenty-seven students, was taught by five teachers, one of whom was in charge of designing and coordinating the course. Using a portfolio-based design, the course aimed at providing an introduction to basic ecological theory, together with developing the students' ability to think and write scientifically. The portfolio included nine different tasks: one individual term paper, five individual textbook tasks, and three group tasks. These tasks required the students to engage with different topics and activities, such as summarizing textbooks, writing about self-selected topics, or analyzing data. The tasks were introduced successively throughout the semester; the final grade constituted a weighted average of all tasks per student. Most of the course workload was assigned to student-driven activities, including reading the syllabus, writing drafts, discussing group tasks with their peers, and writing comments for a peer review. A smaller part of the workload was planned for teacher-led activities, including eight lectures, eight tutorials, and eight voluntary oral feedback sessions in which students could discuss their drafts with the teacher.

The software engineering case is based on an undergraduate course in software development within the software engineering bachelor's programme at a Norwegian university of applied sciences (see Table 1). The course, which included 170 students, was planned and taught by one main teacher, supported by another lecturer and four teaching assistants (TAs). The course used a project-based design to introduce students to software programming and project management. The students collaborated in projects throughout the semester to develop a code for a digital board game using the programming principles they learned during the course. The project work was segmented into eight subtasks and was the basis for the final summative assessment. Most of the course's workload involved student-driven activities, including project planning, managing group work, and developing code. Additionally, the teachers introduced relevant theoretical knowledge for the subtasks in weekly lectures; four TAs guided student groups in their project work during weekly coaching sessions and programming labs.

[Insert table 1 here]

Analytical strategy

We analyzed the data qualitatively, following three steps. First, both cases were subjected to a thematic mapping of the course elements and their relations, including teaching and learning activities, tasks structures, assessment and feedback forms, knowledge resources, and use of technology (for

descriptive reports of the course environments, see Damşa [2018] and Esterhazy [2018a]). Second, we conducted a more targeted thematic analysis (Braun and Clarke 2006) that focused on the feedback opportunities in the courses. In this analysis we used the course documents and teacher interviews in order to provide theory-informed analyses of the different course arrangements that emerged as relevant to designing for productive feedback. This analysis focussed on the following themes.

- *Relation between planned feedback opportunities and the organization of tasks.* This theme refers to the epistemic and material aspects of the course designs and how teachers justify the way they arrange feedback opportunities in relation to the planned tasks. Relevant aspects include (1) the kinds of tasks students are expected to engage in, (2) how tasks are organized in time and space, (3) how the teacher envisions the students' access to information about the quality of their work, and (4) what space is envisioned for students' own initiatives and adjustments to challenges that might emerge.
- *Relation between planned feedback opportunities and the distribution of responsibilities.* This theme refers to social aspects of the course designs and the way teachers justify the different roles and responsibilities they envision for the feedback processes. Relevant aspects include (1) mandatory versus optional activities, (2) peer-to-peer versus teacher-student modes of interaction, and (3) the way responsibilities are distributed among participants in the course.

In a final step, we used the same themes to analyze the student interviews in order to identify how students experienced the feedback opportunities in their courses as productive for their learning and what role the task organization and distribution of responsibilities played for their experiences. These steps allowed us to appreciate the similarities and differences between the ways in which feedback opportunities were incorporated and experienced within the two course designs.

Findings

Addressing our first research question, our analysis shows that the organization of tasks and the planned distribution of responsibilities among course participants are at the core of their different ways of incorporating feedback opportunities in the course designs. In the following, we present how feedback opportunities related to a) the different task organizations, and b) the different ways of distributing responsibilities within the two course designs

Feedback opportunities as related to task organization

Biology: Iterative task organization and scheduled feedback opportunities

Feedback played a central role within the biology design. The teacher explained that 'the key rationale for including feedback and the opportunity for [students] to respond is that this is where learning happens' (pre-interview). The teacher thus chose a portfolio-assessment design with several portfolio tasks and 'feedback and chances to improve during the course, so [that students] can redo based on the comments they receive – both from me and from other students' (pre-interview). The teacher thought it was important for these feedback opportunities to remain formative and that the students' work would not be evaluated before the end of the course.

The way in which the teacher arranged the course elements to generate feedback opportunities was related to the envisioned course aims and task organization. The teacher explained that the students would be 'continuously … fed with new [tasks] that they have to do' (pre-interview) during the semester. These tasks appeared as separate items with distinct topics, which taken together were

meant to form a comprehensive portfolio that would introduce the students to the diverse knowledge domain and would ensure their mastery of the basic 'language of ecology' (pre-interview). As a consequence, the task organization was divided into nine parallel tracks: one for each portfolio task (see visualization in figure 1). The teacher scheduled a number of feedback opportunities along these tracks. For each task, the course plan provided students with an *explicit schedule* containing the dates at which the task would be released, the deadline by which students needed to submit their drafts if they wanted written feedback, the dates for oral feedback sessions, and the deadlines for resubmission of the revised/final versions.

The teacher justified this explicit plan by arguing 'It's very transparent, I think, for the students to see exactly what is expected' (pre-interview). The teacher thus attempted to support the students in navigating the multilayered arrangement of tasks and feedback opportunities. The teacher justified this organization of written and oral feedback opportunities by the common way of working within this discipline: 'This opportunity to change and resubmit … is also closer to real life, isn't it? … We interact; I suggest they change; we look at it again. I think that's quite a normal way of working and making things better' (pre-interview). The teacher planned that these opportunities would follow the same schedule for each task. One exception was the individual term paper, for which additional feedback opportunities were planned, including teacher feedback during oral presentations of the term paper, and a written peer review.

The teacher's plan to assign the different tasks gradually throughout the semester created a multilayered, iterative schedule that included specific planned times for feedback opportunities for each task but had little synchronization between tasks. Any knowledge generated in one feedback encounter was thus meant to relate exclusively to one specific task while remaining independent of the other tasks students might be working on in parallel. The fact that the nine portfolio items formed standalone tasks, each with its own specific topics and requirements, made detailed descriptions for each task necessary. This setup also implied that the teacher expected that the content and focus of the feedback opportunities would be regularly renegotiated in order to provide the knowledge content, resources, and strategies relevant for the respective task.

[Figure 1]

Software engineering: Cumulative task organization and impromptu feedback opportunities

Feedback also played a central role in the software engineering course design, which related to the course's main aim of introducing students to the problem-solving strategies typical of the software engineering domain. The teacher explained that 'in programming there isn't just one solution to solving a problem. There are many ways.… So we can coach them how to find the right solutions, but it's the students themselves who need to take the steps to find those solutions' (pre-interview).

The teacher employed a project-based pedagogy, intending to create authentic learning challenges that would introduce students to skills needed in their professional lives. Feedback opportunities were seen as central elements in supporting the students in learning and developing problem-solving skills and in working independently on their projects. The teacher explained that 'one of the reasons why we offer so much support, both through coaching sessions and programming labs, is because programming is difficult. We want to give them as much support as possible – both a close weekly follow-up and opportunities for the students to ask questions directly, for example during the lab …. The students need to work by themselves, but they also get support from us' (pre-interview).

The teacher acknowledged the importance of 'predicting how much students can do during a whole semester and how difficult the project should be' (post-interview). For that reason, the project

work was structured into eight subtasks that were closely interdependent and followed a cumulative logic, such that one subtask formed the basis for the next. The intention of the gradually increasing complexity and difficulty of the subtasks was to structure the students' activities and to create a continuous need to use the course's feedback opportunities.

The project's central role in the design was also reflected in the way the other course elements were arranged around the task. For example, the teacher 'first created the project and after that structured the lectures' (pre-interview). The teacher envisioned the lectures as a support to the project by introducing conceptual knowledge content relevant for the corresponding subtask. The students were meant to experience a close relation between the project, and the lectures, labs, and coaching sessions. The teacher envisioned these activities as being arenas for feedback opportunities where students could get help and 'talk with their [TA] if they were unsure about' a certain concept (task description).

The subtask organization implied that the students were to work on a continually evolving product that was only to be fixed in time and space upon final submission and during two scheduled formative assessment moments ('checkpoints') during the semester. The teacher accounted for the nature of this evolving product by planning for feedback opportunities in the form of oral guidance on the ongoing project activities during coaching sessions and programming labs, rather than scheduling specific times for written comments on iterative project drafts.

While the course documents were not particularly explicit about feedback, the interviews showed that implicit pedagogical ideas about feedback and teaching informed the teacher's course design decisions. For example, the planning of feedback opportunities during programming lab sessions was related to the existence of a physical space that students at this particular university commonly used for group work. In addition, the hiring of TAs to help students with their group work was common practice in the study programme.

The cumulative nature of the project enabled the teacher to remain flexible and not to have to specify all feedback opportunities up front. The project task was the course element that influenced all other planned course activities. As a result, the most explicitly described course elements were the subtasks, including detailed explanations of what students had to do, where to find resources, and how the different subtasks build upon each other. These subtasks made up a total of forty-three pages of written instructions. These instructions provided a 'navigation map' of the course and indicated the task sequence the students should follow. Because of this meticulously planned task organization, the teacher expected that the feedback opportunities would emerge by themselves in the coaching sessions and programming labs, and thus required less explicit specification from the teacher.

In summary, the course elements in the software engineering course were arranged in such ways that arenas would be generated in which impromptu feedback opportunities could emerge. These arenas were demarcated by the scheduled times and locations of the weekly programming labs and coaching sessions. As such, these arenas constituted a space in which the task organization of the project work could unfold and in which the students could have the opportunity to obtain any help they needed to keep up with the intended task progression. Figure 2 shows a visualization of the feedback opportunities' relation to the task organization.

[Insert Figure 2 here]

Distribution of feedback responsibilities

The two designs differed in their distribution of responsibilities related to the feedback opportunities. The biology students were expected to organize their own work throughout the semester, which

implied they had responsibility for meeting submission deadlines to receive written feedback; and for booking appointments for oral feedback sessions. The fact that each of the five teachers was responsible for providing written and oral feedback on those portfolio tasks he or she had designed implied that the students would have to engage with a complex arrangement of people during the different feedback opportunities.

The small size of the biology course caused the teacher to consider the provision of individual feedback as feasible. The fact that the teacher positioned feedback opportunities early on in the task sequence may be interpreted as an offer to take co-responsibility for the quality of the students' work. The main teacher did make clear, however, that the students were still responsible for making use of the feedback opportunities and for developing a good final version of their work. The teacher thus planned to take on a double role: as an advisor during the course and as an objective assessor afterwards.

Similarly, in the software engineering case, the students were required to work continuously on their projects, attend coaching sessions, and seek feedback from the TAs. The teacher explained: 'We try to make the students take responsibility. And even if we offer all these activities, it is still the students who have the responsibility to engage in these activities at their own speed' (pre-interview). This outlook also implies that any students who would fall behind despite the offered feedback opportunities were perceived as cases beyond the realm of teacher responsibility. This situation was also related to the large size of the class: 'There are so many students that it is simply not possible to give them individual feedback … if students have problems, they need to come to the TA or to me and get feedback through that process. So the best way to get feedback is to seek feedback' (pre-interview).

While remaining in a distant position, the teacher still took responsibility for the students' learning by creating arenas that included feedback opportunities. To make it easier for the students to seek feedback, the teacher assigned TAs as contact points for the different student groups, with the aim of creating a continuous and stable relationship between the students and the TAs.

Another important aspect in the distribution of responsibilities was the teacher's idea that the course was meant to prepare students for the types of feedback opportunities they would likely encounter within the software engineering profession: 'Right from the beginning, my goal is to get students to try to find their own information channel – whether that might be the internet, a book, or videos' (pre-interview). This intention to support the students in becoming autonomous learners who know where to find feedback opportunities and how to capitalize on the same was reflected in the variety of knowledge resources the teachers intended to make available in their lectures and through the task descriptions.

Student experiences of feedback opportunities

Addressing our second research question of how students experienced the feedback opportunities, both biology and software engineering students reported that they found the opportunities to be productive for their learning. They had different experiences with regard to the task organization and the responsibility implied by the design when seeking and making use of feedback opportunities.

The software engineering students reported that they appreciated the cumulative task organization, stating that 'we learned so much from [the project] and I think in the future when we get other tasks like create a program … we can do it because it's a blueprint for everything'. The fact that the project task was sub-divided in smaller cumulative subtasks was experienced as a very useful insight for their future programming practice. Students said they learned that '[you have to] try to split

[the whole code] up as much as you can because then you have more control. Maybe it's the most important lesson'. The complexity of the project made one student suggest that it would have been good to 'have somebody helping us be a project manager, not that they would manage the project, but tell us what questions we should ask ourselves about our progress . . . coaching us in being project managers for the project'. This shows that students realized that becoming software engineers also implies developing good practices of identifying and capitalizing on feedback opportunities to ensure efficient work processes.

The software engineering students experienced they were given the responsibility for finding their own solutions and asking for help when needed. Talking about the teacher, they said 'he is helpful when you ask for help, but when he gives you that assignment, he usually writes it like so you have to think about what he really wants us to do … it's frustrating, you have to think a lot, but I think you learn quite much when you do it like that'. While causing frustration at times, this shows that students also realized that asking for feedback was something they needed to learn, both as students in a course that requires participation and as prospective software engineers.

In the biology course, students reported that the submission deadlines during the semester made it easier to work continuously rather than just working towards the end. Most students said they learned a lot from getting feedback along the way. Some students, however, admitted not having handed in all assignments and therefore having missed out on some feedback opportunities: 'I wish there was more written feedback because we couldn't attend the feedback sessions. But I mean I can't really complain about anything because in my case I haven't even submitted things by the feedback dates sometimes because I haven't had time'. This shows that students were aware of the responsibility they were given to make use of the feedback opportunities offered by their teacher. Addressing exactly this issue, some students suggested it would have been better to make all draft submission deadlines during the semester obligatory, thereby shifting responsibility back towards the teacher.

Concerning task organization, the biology students indicated that they appreciated that the variety of tasks gave them insight into the different ways of working in ecology: 'Different [teachers] have many different assignments for us. It's been very interesting to see how they actually work and what kind of subjects [and] experiments they want us to do because it's kind of relevant for what we're gonna do later on'. The distinct tasks, however, had the effect that students felt it was difficult to use feedback across the topics: 'When I'm working with one of [the tasks], I'm working with that one. And I think that the subjects are so different that . . . they don't really overlap that much'. Another challenge was related to the fact that some task descriptions were perceived as unclear, which required students to use the feedback opportunities only to find out what they were to do in the first place. One student described her experience: 'For me it was a bit vague what, how much did we have to write in each assignment and what did he actually want us to answer. So . . . there was a lot of thinking and a lot of stress before the work actually started'. This situation caused some frustrations and meant that some feedback opportunities did not take the form of productive dialogues about the students work but rather turned into clarifications of technicalities.

In summary, how students experienced and made use of the feedback opportunities was related to the ways tasks were organized and how students perceived their responsibilities with regard to seeking and using feedback. Clear responsibilities and task structures were generally appreciated and made it easier for students to use the feedback productively for their immediate tasks. Students perceived the different logics of organizing tasks and feedback opportunities – cumulative versus iterative – as relevant for their learning in the disciplines and in both cases, students experienced these particular course arrangements as preparatory for their future careers as biologists or software engineers.

Discussion

This study illustrates how productive feedback takes distinct forms within two course designs, which also affected how students experienced the feedback opportunities as productive for their learning. The core aspects that distinguished the designs included the ways in which the teachers envisioned (1) how the feedback opportunities relate to the different tasks and (2) how responsibilities are distributed in regard to the feedback opportunities. This setup matches Goodyear's (2015) description of designs as operating through the way in which teachers specify tasks, tools, resources, and the division of labour that should be used within the design. At the same time, our findings add specificity to these design elements and what they might look like in different course contexts.

Our analysis has shown that the task organization was especially significant for the way in which feedback opportunities were incorporated and the degree to which these opportunities were prescribed. The biology design showed an iterative task organization, in the sense that students' recurrent opportunities to revise and improve their assignments were described explicitly for each task. The software engineering design had a cumulative task organization, since feedback opportunities were envisioned to emerge spontaneously during coaching sessions and to be related to only one product that the students worked on over time. These finding underscores that we should understand task organization not only as a way of organizing knowledge content to be worked with but also as ways of envisioning social and temporal structures for student learning. As such, task organization is consequential for how feedback opportunities are sequenced and ordered within course designs and for how students experience these opportunities.

These findings add to earlier studies that have highlighted how the careful organization of course elements is important for supporting productive feedback (Carless et al. 2011). In our study, both course designs catered for productive feedback through different arrangements of course elements. Both teachers wished their students to become independent learners and were concerned with supporting their learning beyond the course context. In both cases, the task organization required students to self-organize their work with the course content, either by working on several portfolio tasks throughout the semester (biology) or by developing a computer game on their own (software engineering). As both teachers acknowledged, this focus on independent work made it important to plan for students to have opportunities to obtain guidance and feedback from their more experienced peers and teachers along the way. As shown by the student interviews, the fact that the students were free to work at their own pace and ask for feedback whenever necessary allowed them to take command of their own learning and helped them develop skills to work independently.

Both designs catered for productive feedback according to the principles suggested by Boud and Molloy (2013). First, both designs positioned students as prime agents in the learning process by emphasizing independent student work and an orientation towards future learning. Second, the designs provided opportunities to work on multiple well-designed and sequenced tasks that would allow for progressive knowledge generation. Third, the designs provided access to relevant knowledge that the students could immediately use to improve their work. Finally, the designs gave the students opportunities to practice how to provide and seek feedback. These principles were also reflected in the ways students experienced the feedback opportunities as productive for their learning.

The fact that these characteristics were shown to take markedly different forms in the two different course contexts, however, provides empirical support that models for productive feedback should not be treated in a generic way. Rather, we should pay more attention to the various ways in which course elements are arranged in different types of courses; and to how feedback opportunities are generated by these different arrangements.

To further examine the differences between the two cases and the way their designs catered for productive feedback, we need to turn to the cases' specific disciplinary characteristics. In both cases, the arrangement of course elements followed the knowledge forms and practices that characterized each given discipline (Trowler 2012). In the biology case, the core knowledge forms the students were supposed to engage with comprised theoretical knowledge in ecology, capacities to read and summarize scientific literature in the discipline, as well as skills in using software for ecological modelling. The course designs handled the various knowledge forms in different ways, through distinct tasks and planned activities. The teachers' justifications and the students experiences indicate that the portfolio-based design and its distinct feedback opportunities, which encouraged student work with several separate products rather than an integrated whole, suited the disciplinary character of ecology and its diverse knowledge forms and practices. Software engineering, in contrast, is typically characterized by a preference for a project-based way of working, which forms a core approach both for professional engineering work and for engineering education (Nerland and Damşa 2018). This characteristic was reflected in the teachers' justifications and the students' experiences, which showed how the integrative and cumulative character of the project task and the related feedback opportunities modeled real-life engineering work. In addition to the disciplinary context, the ways teachers planned for feedback in their courses may have also been influenced by the institutional setting. However, in both cases teachers generally drew stronger on disciplinary practices for justifying their designs than on institution-specific requirements.

While the literature has shown how disciplinary characteristics influence teaching and learning in higher education (Trowler 2012), our analysis suggests that such characteristics are also consequential for the social relations that characterize feedback. In the biology case, the distinct knowledge forms that characterize ecology made it necessary to distribute responsibilities for teaching and feedback opportunities among several teachers that held each a different specialization. In the software engineering case, the division of responsibilities was different. In this case, productive feedback was catered for by organizing people and places so that feedback opportunities could occur, and by securing the availability of competent peers rather than distributing responsibility among specialized teachers.

The differences we found in this study confirm earlier findings that it is important for teachers to have a general understanding of learning processes and pedagogical support mechanisms in order to be able to envision how feedback opportunities might be incorporated in a given course design (Tuck 2012; Xu and Carless 2017). We suggest that it is equally important that when teachers plan for feedback opportunities, they should consider the forms of knowledge and practices that make up the discipline in question as well as the types of learning challenges these practices entail.

Concluding remarks

This study contributes to the field of feedback research in several ways. Empirically, the two cases illustrate how designing for productive feedback can take different forms and is influenced by the practices and discourses of the given discipline. In order for designs to cater for productive feedback, they must incorporate feedback opportunities in which students can access knowledge on how to immediately improve their work with their task as well as on how to seek, generate, and make use of feedback in their future work. These opportunities can be generated by arranging course elements such as knowledge, activities, tools, and responsibilities in ways that will be conducive to engagement and future use.

Conceptually, our study contributes to the further development of a relational view on feedback. We argue that productive feedback is an integral part of course designs that is characterized

by the specific disciplinary context. This view is novel as it implies that the provision of productive feedback has to do with more than providing good feedback comments. Instead, it highlights that the different ways in which elements of the course design are arranged and related to each other and to the wider knowledge domain are also important factors for making feedback productive.

Finally, our study makes a practical contribution to the field. It shows that designing for productive feedback does not have a one-size-fits-all solution. A feedback design that fits one course might not play out productively in another course, if it does not align with the common task organization and distributions of responsibilities in the given context. The study also provides specific examples of how teachers can design for productive feedback in their courses by illustrating two different ways of organizing tasks and responsibilities in a course design. These arrangements generated, each in their own way, opportunities for students to make use of feedback to improve their understanding and performance. To further develop our understanding of the different ways teachers may cater for productive feedback, more research in different disciplinary and institutional contexts is recommended.

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Declaration of interest statement

No potential conflict of interest

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Table 1: Main characteristics of the two case studies

Course title	'Ecology'	'Software development'
Pedagogical design	Portfolio-based design	Project-based design
Main rationale	Develop knowledge of basic ecological theory, analysis and writing skills	Develop theoretical and practical skills in object-oriented programming
Level of study	B.Sc. program in biology	B.Sc in software engineering
Course period	Twenty weeks	Eighteen weeks
Number of teachers/TAs	One main, four co-teachers	One main, one co-teacher, four TAs
Number of students	27	170
Task organization	• Three group tasks (3 students) • Six individual written tasks • Peer feedback on one task	• One group project (3 students) over whole course period • Divided into eight sequential sub-task
Final assessment	• One final grade per student; based on weighted average of all tasks	• One final grade per group project
Supporting teaching and learning activities	• Lectures • Tutorials • Feedback sessions	• Lectures • Coaching sessions • Programming labs

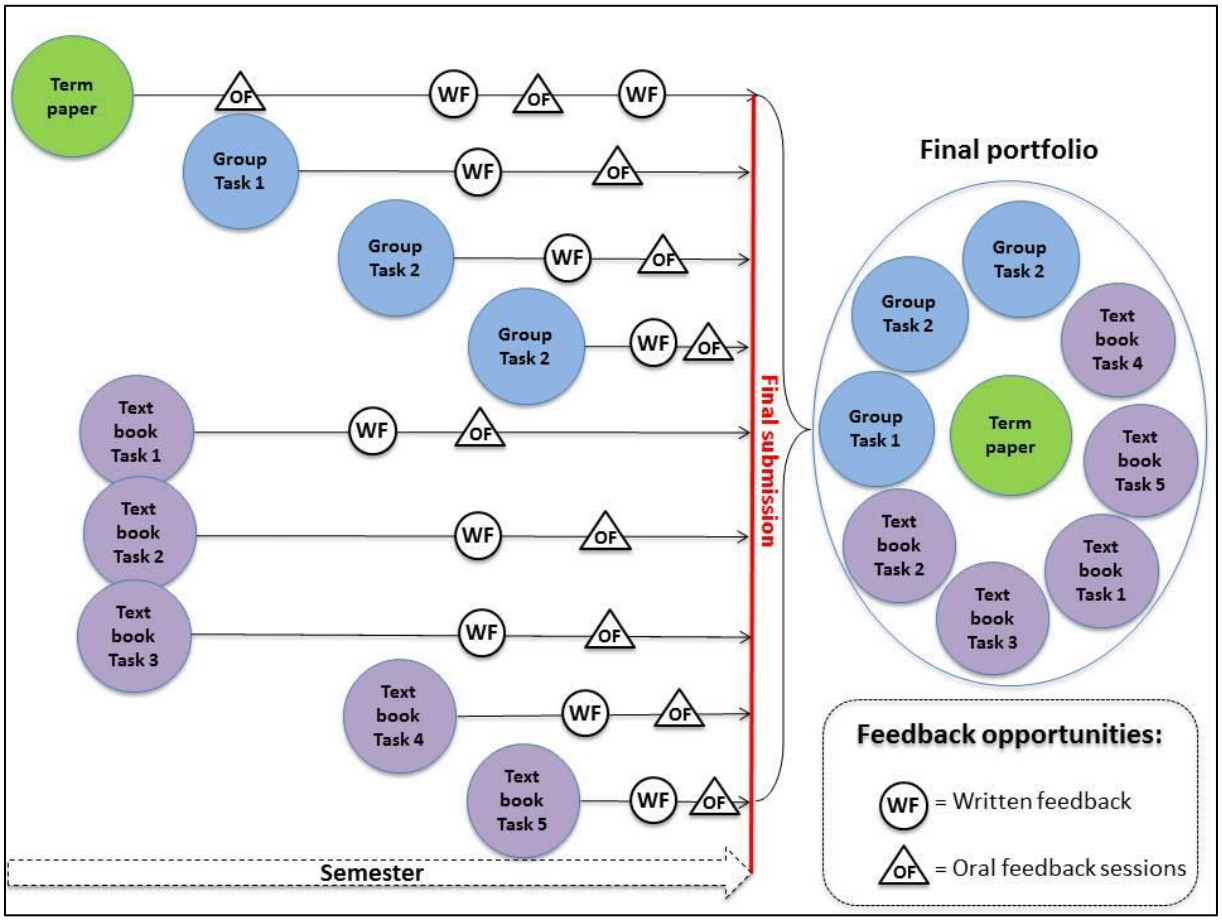

Figure 1: Feedback opportunities in relation to the task organization in the course design of the biology case

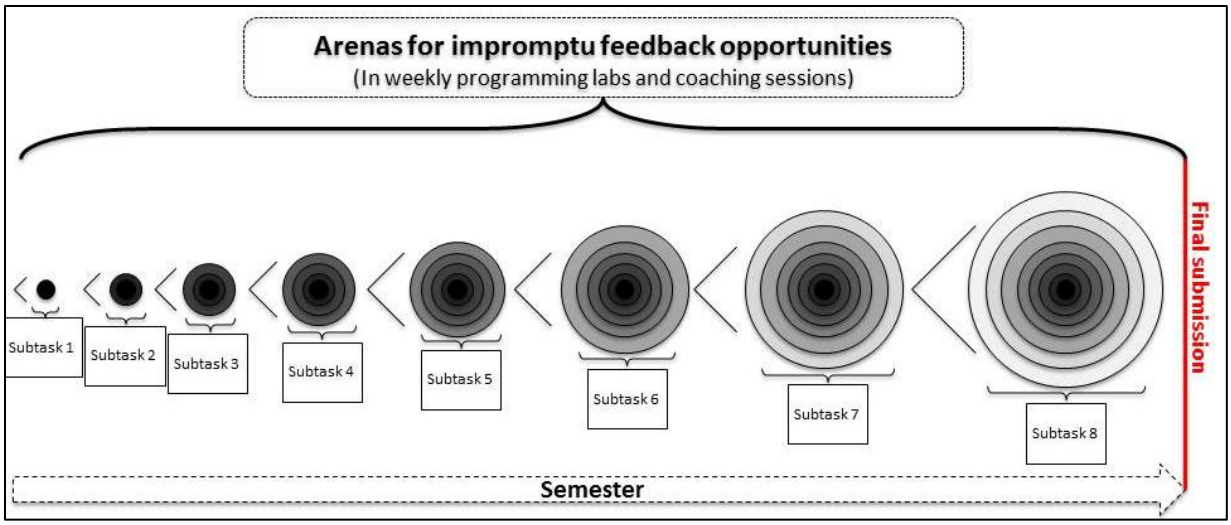

Figure 2: Feedback opportunities in relation to the task organization in the course design of the software engineering case