Aug 10th, 12:00 AM

Improve Your Modeling Skills with the Help of Your Peers – Developing and Introducing a Digital Case Study and Peer Feedback App in an Information Systems Class

Sebastian Hobert
University of Goettingen, shobert@uni-goettingen.de

Andreas Edler
University of Goettingen, andreas.edler@uni-goettingen.de

Christine Jokisch
University of Goettingen, christine.jokisch@uni-goettingen.de

Julian Busse
University of Goettingen, julian.busse@uni-goettingen.de

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Completed Research Full Paper

Sebastian Hobert
University of Goettingen
shobert@uni-goettingen.de

Andreas Edler
University of Goettingen
andreas.edler@uni-goettingen.de

Christine Jokisch
University of Goettingen
christine.jokisch@uni-goettingen.de

Julian Busse
University of Goettingen
julian.busse@uni-goettingen.de

Abstract

The overall goal of this research study is to improve students' modeling skills in large-scale educational settings by providing video-based case studies and introducing a formative peer feedback process to enable asynchronous, anonymous collaboration among the students. To this aim, we designed a learning concept and implemented an app that supports the provision of video-based case studies and the conduction of a double-blind peer feedback process. Our results from introducing the digital learning concept in an introductory course targeting information systems students indicate that the students' motivation and reflection on the learning content could be fostered, and their modeling skills could be improved. Overall, we contribute with insights into how to conduct video-based case studies combined with peer feedback processes in information systems education.

Keywords

Peer feedback, case studies, collaboration, technology-enhanced learning, modeling skills.

Introduction

Modeling skills (like business process modeling) are an essential part of many information systems (IS) or computer science study programs (see, e.g., Recker and Rosemann 2009). As future is employees, they enable students to gather the as-is state of business processes or systems. By learning how to model, students can improve their conceptualization and abstraction skills (Recker and Rosemann 2009) as well as their visualization skills. Acquiring these skills are important core competencies of future IS specialists. Learning how to model is, however, a challenging task. First, formal notations, modeling rules, and visualizations of modeling languages need to be learned. Second, the given situation or (business) case needs to be analyzed. Third, a model needs to be created that meets the contextual and formal requirements. Thus, it requires different knowledge dimensions (see, e.g., Anderson and Krathwohl 2001) to succeed.

In many IS study programs, learning how to model is part of the study entry phase and taught in introductory courses. As part of the curriculum, often different modeling languages are covered and taught in-class to practice and apply the theoretical learned modeling languages in pseudo-realistic settings. Many lecturers often provide exercise tasks or case studies to the students enabling them to train their modeling skills. Such case studies or exercises often consist of (textual) descriptions of problem situations that should be analyzed and modeled. In our experience, textual case studies can, however, lead to a rather low authenticity. More authentic and practice-oriented case studies are, however, desirable.

In many higher education institutions, introductory courses are dominated by increasing large-scale settings, which is considered to be a challenge (Maedche et al. 2019) due to resource constraints. This often results in learning settings that can be described with a high student-to-lecturer ratio. Particularly when

learning complex skills (like modeling), it would be helpful for students to use "the power of feedback" (Hattie and Timperley 2007) to improve learning, e.g., by offering individual feedback on the students' homework tasks (i.e., the case studies or exercises). Due to the existing resource constraints, offering an individualized learning setting in which the lecturer is able to adapt to the individual needs of each student and to offer each student feedback on her or his case studies is challenging. This becomes increasingly difficult during the COVID-19 situation due to the still-evolving and frequently changing learning settings (e.g., switch between in-class, hybrid, and distance learning).

To address the described challenges, we designed a collaborative learning app that integrates realistic video-based case studies with a digital peer feedback process. In particular, our research approach is inspired (1) by the anchored instruction approach by creating video-based case studies (see, e.g., The Cognition And Technology Group At Vanderbilt 1990) and (2) by peer feedback processes (Liu and Carless 2006). Peer feedback is known, for instance, from scientific publication processes (a.k.a. peer review) and can be used for evaluating formative assessments. By utilizing this combined approach, the students first get the possibility to train their modeling skills using realistic case studies, and second get (anonymized) feedback from peers in a collaborative, technology-enhanced setting. Each student does not only work on her or his own modeling skills but is also involved in reviewing the solutions of their fellow students. Thus, our technology-enhanced peer feedback process does not only aim to foster the students' modeling skills but might also foster their critical thinking and reflection abilities.

Based on this problem setting, we followed a design science research approach (Peffers et al. 2008) to develop our digital peer feedback app and instantiate and evaluate it in a field setting. In doing so, we address the following research question in this paper:

RQ1: How to design a digital case study and peer feedback app for supporting students in improving their modeling skills using video-based case studies?

RQ2: How do students of an IS class interact with and evaluate a digital case study and peer feedback system?

The remainder of this paper is structured as follows: Next, we briefly describe the foundations of our work in Section 2. In Section 3, we give an overview of our research design, focusing on the development and evaluation steps. Afterward, we present our developed app and provide an overview of the design of our video-based case studies. Then, we outline the findings of introducing the peer feedback software in a field study. Finally, we discuss our findings and summarize the results.

The Concept of Peer Feedback

For many years, feedback has been recognized as an important component of teaching and learning that can influence learning success (Hattie and Timperley 2007). In educational settings, both summative and formative assessments are widespread. Summative assessments focus on assessing the learners' performance, typically at the end of a learning process, for instance, by evaluating a student's exam to determine a grade (Topping et al. 2000). In contrast, formative assessments usually do not focus on grading but focus on providing students input and information about their learning process (McCarthy 2017; Topping et al. 2000). Thus, formative feedback is usually not located at the end of a learning process but is provided during the process. It has the potential to show the students opportunities for improving their own learning processes.

In this project, we mainly focus on formative assessment using the peer feedback concept. According to McCarthy (2017), "[p]eer feedback is a process in which students provide comments and critiques on their peers' submissions […]". As we focus on a learning setting in one particular university course, the students act in two roles during the peer feedback process: (1) they get feedback from their peers on their own submissions, and (2) they are assessors who analyze and evaluate the fellow students' submissions to provide non-graded feedback – this task allocation to be a typical form of peer feedback (McCarthy 2017).

Research Design

To address our research goal of finding a solution for supporting students digitally using a peer feedback system, we follow a problem-oriented design science research approach adapted from Peffers et al. (2008)

to design and develop the peer feedback app. As part of the development process, we also design video-based case studies. Figure 1 shows an overview of the six steps of our research process.

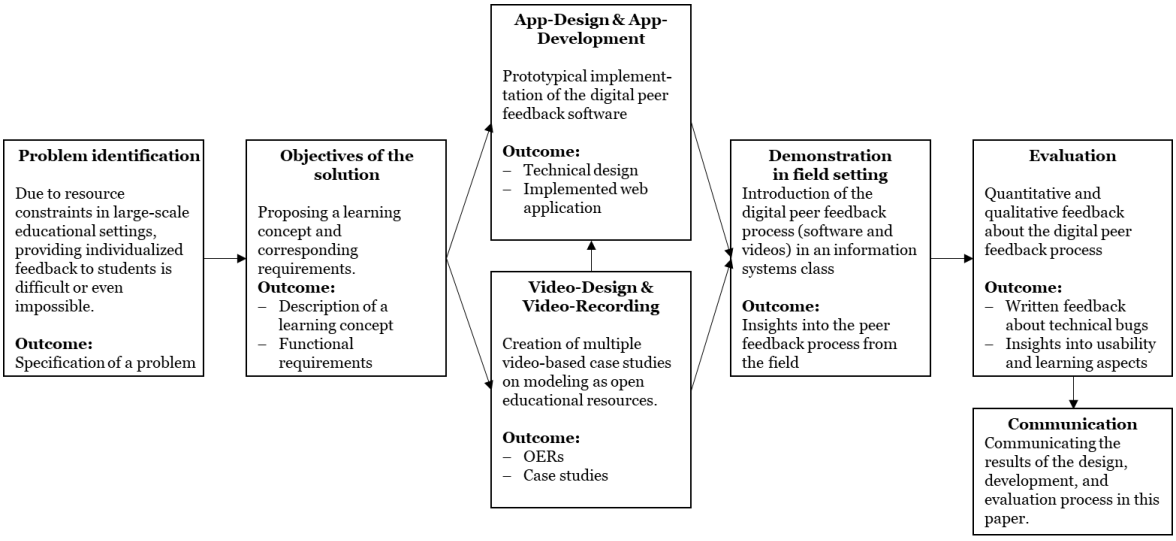

Figure 1. Overview of the Research Design

Using this design science research approach, we aim at finding a solution for the given problem of providing all students in a large-scale learning setting with individualized feedback on their own solutions of authentic case studies. Based on this first step in the design science research process, we derived the objectives of a solution by outlining a learning concept as well as functional requirements for our digital case study and peer feedback app. In the third step, we first finalized the overall app design and implemented it. Second, we designed and recorded video-based case studies as open educational resources (OER) integrated into the developed app.

After finishing the development and creation steps, we integrated the digital peer feedback system into a university course targeting IS students. A detailed overview of the course setting is described below. During the course of one semester, the students worked on three video-based case studies, including a peer feedback cycle for each case study. After completing all three case studies, we asked the students to provide us feedback using a questionnaire as part of the evaluation step in our design science research approach.

Using this approach, we strive towards contributing to both the technical research direction of technology-enhanced learning and the didactical-focused content development and usage in the field.

Designing a Digital Peer Feedback Process for Video-based Case Studies

In the following, we outline the steps for developing the digital case study and peer feedback process by focusing on the overall concept, the app development, and the creation of video-based case studies.

Overall Concept and Corresponding Requirements

The main objective for the presented design science research project is to offer students individualized, timely feedback in order to improve their learning process – even in large-scale learning settings. Additionally, we want to increase the students' engagement by encouraging them to interact with the contents from different perspectives with the help of the peer feedback concept:

1. Working on their own on modeling a solution for the case study
2. Reviewing the works of fellow students in a double-blind peer feedback process
3. Reflecting on the received peer feedback for their own solution
4. Working on an improved solution

Based on these project goals and typical characteristics of peer feedback, we conceptualized a four-step process that we thrive to implement in a digital peer feedback system (see Figure 2).

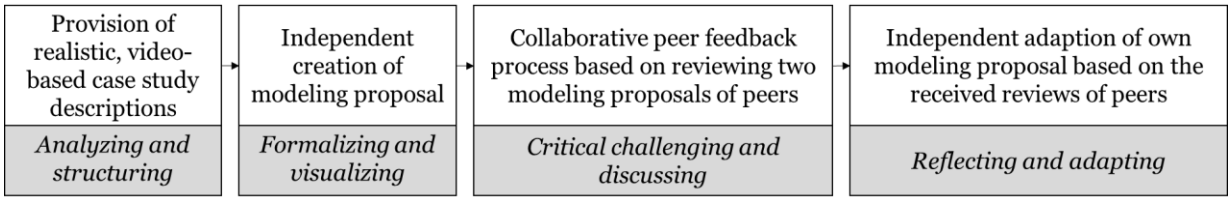

Figure 2. Desired Case Study and Peer Feedback Process

In the first step, the students need access to the case study description. As we aim to provide students with realistic case settings, we follow the idea of the anchored instruction approach (The Cognition And Technology Group At Vanderbilt 1990). Thus, the cases should be provided as videos in which pseudo-realistic enterprise scenarios are shown (requirement R1). This form of visualization should provide an engaging visualization form that can be supplemented by additional information (like PDF files or presentation slides).

In the second step, the students' task is to solve a given problem statement and submit their individual solutions to the digital peer feedback system. For instance, the students should create a modeling proposal for a business process model based on the video description in step 1. As we want to enable students to work with professional modeling software, we do not aim to integrate a web-based modeling solution but provide them with desktop-based modeling software. After working on their solution with desktop-based modeling software, they should submit their solution (R2) to the digital peer feedback system (Alcarria et al. 2018; Simionescu et al. 2017).

In the third step, the actual formative peer feedback process takes place. To this aim, the system should randomly assign (R3) the students' submissions to fellow students (Simionescu et al. 2017). Each student should critically review two fellow students' submissions and provide helpful and supportive feedback (R4). To reduce biases, the peer feedback system should follow a double-blind approach in which both, the reviewers as well as the reviewees, are anonymous. This seems to be a common approach for peer feedback (Indriasari et al. 2020).

Finally, in the fourth step, the students get access to their fellow students' reviews (R5) and should reflect on their own solutions. After identifying possibilities for improvements, the students should revise their first submission and upload their final case study solution (R6).

Table 1 summarizes the concept based on the derived functional requirements.

	Functionalities	**Exemplary citations**
R1	Provision of video-based case studies with optional supplementary materials	(The Cognition And Technology Group At Vanderbilt 1990)
R2	Upload functionalities for submitting case studies	(Alcarria et al. 2018; Simionescu et al. 2017)
R3	Randomized assignment of two reviews for each student	(Indriasari et al. 2020; Simionescu et al. 2017)
R4	Functionalities to conduct double-blind reviews	
R5	Functionalities to view anonymized reviews	(Indriasari et al. 2020)
R6	Upload functionalities to submit revised submissions	

Table 1. Summary of Core Requirements

Developing the Digital Case Study and Peer Feedback App

Based on the derived case study and peer feedback process (Figure 2) and the functional requirements (Table 1), we implemented our web-based case study and peer feedback app. We implemented the app using common web technology, including HTML5, CSS3, and JavaScript. To enable students to access the app on any device and provide a usable user interface, we used common open sources frameworks like Bootstrap (Mark Otto, Jacob Thornton and Bootstrap contributors 2021) with the AdminLTE theme (Github 2020).

After logging into the digital case study and peer feedback app, the students get access to organizational information about the current case study (see Figure 3 top left). The timeline of the whole process starts with (1) solving the case study and submitting the first solution, (2) the review phase with two review tasks for each student, and (3) the revision phase in which the students receive the peers' feedback and need to upload their revision.

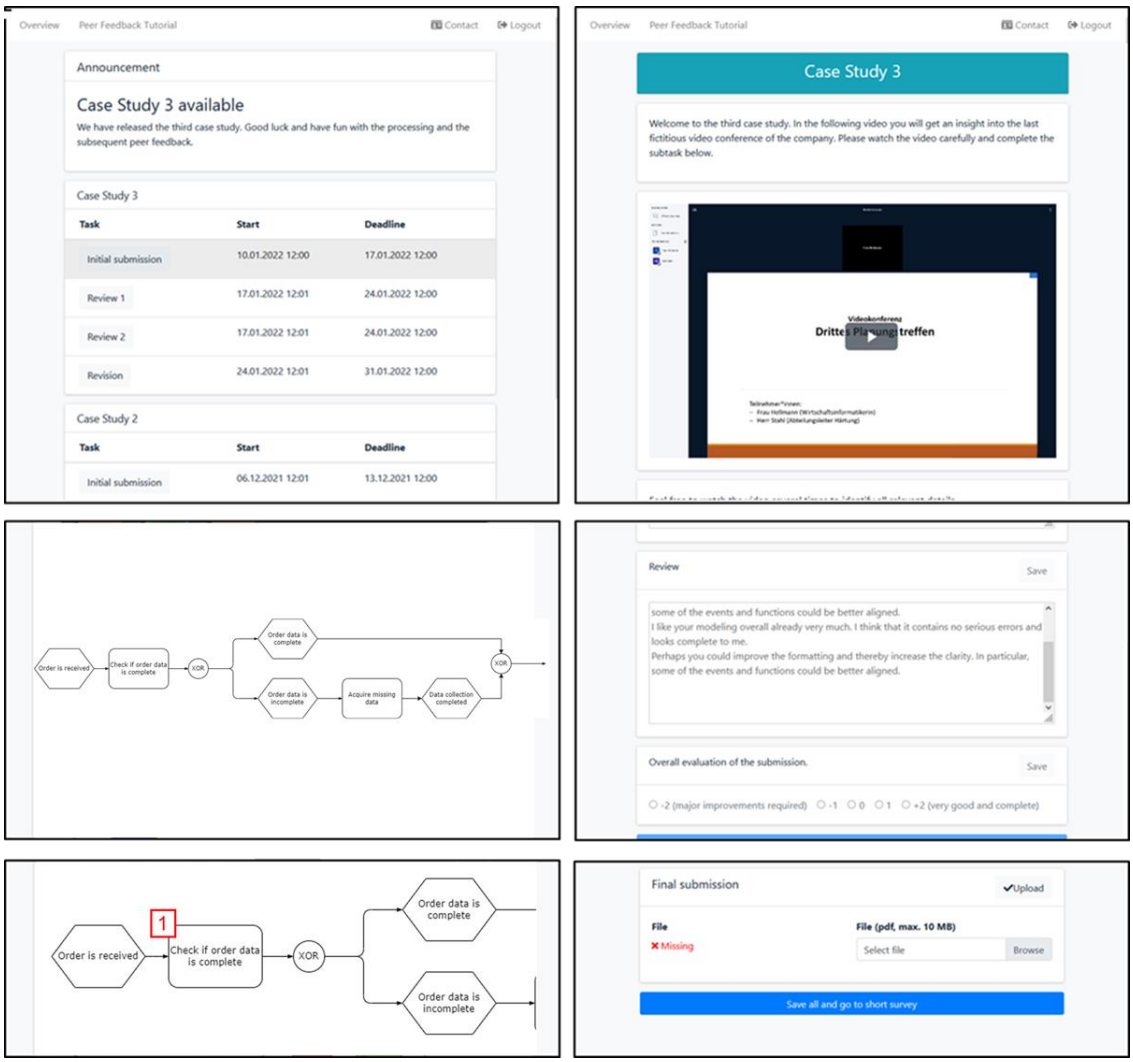

Figure 3. Screenshots of the developed app (translated, with sample data)

While the first phase is active, the students may watch the video-based case descriptions as often as they like (see Figure 3 top right). The integrated video player allows the students to skip certain parts or watch specific sections multiple times. This enables them to work through the video-based cases intensively. The app also allows providing further supplementary materials to the students, like PDF documents for additional textual inputs or graphics. Supplementary information can be used to make the case more

authentic – watching the video was in our setting sufficient to solve the case. Afterward, the students need to upload their modeling solution as a PDF file.

After all students submitted their first solution to the app, the app automatically allocates the reviewing tasks. For each student, two reviews were assigned. Important to notice is that the app does not reveal the students' names to their fellow students to enable a double-blind peer review. During the reviewing phase, the students may access the assigned solutions of their peers directly in the app. To this end, the app visualizes the uploaded modeling solution (see Figure 3, middle left) and enables the students to insert comments by clicking on the elements. Additionally, text inputs are available for giving additional feedback (see Figure 3 middle right). We specifically asked the reviewers to provide feedback on the correctness of content and form as well as the overall quality of the solution.

Finally, in the last phase, the students can access the feedback via the app (see Figure 3 bottom left), revise their solution, and submit the final version (see Figure 3 bottom right).

Designing Video-based Case Studies on Software Modeling

In addition to designing the app, we conceptualized and produced three video-based case studies for the field test. From a content perspective, the three case studies target a fictitious company. In the first case study, an exemplary business process should be analyzed and should be improved afterward. Based on this analysis, a data-oriented conceptual design of a new information system should be created in the second case to enhance the business process. Finally, the technical implementation of the system is addressed in the third case study.

From an instructional design perspective, we ground the video production on the anchored instruction approach (The Cognition And Technology Group At Vanderbilt 1990). When producing the videos, it was important to us to create an authentic scenario that helps students to imagine themselves in a fictitious situation. In line with the current situation due to COVID-19, we designed the case studies as screencasts of video conferences (see Figure 4). Within the video conferences, the actors take different roles (e.g., CEO vs. manufacturer) and perspectives (e.g., management view vs. business process view) and can thus create a complex and authentic scenario. We made sure that all videos had a consistent structure to simplify the learning process. All videos, therefore, begin with a short introduction in which the goal of the meeting and the actors are introduced. The actors then discuss the situation in the company before the task is finally explained. The resulting video-based case studies are published as OER (see Professur für Anwendungssysteme und E-Business 2022).

Figure 4. Exemplary Conceptual Structure of the video-based Case Studies (1: list of participants, 2: videos of actors, 3: aim of the video conference, 4: Description of the roles of the actors in the company)

Insights from the Field when Introducing the Digital Case Study and Peer Feedback App in a University Course

Field Setting

We introduced the digital case study and peer feedback app in an IS class at a German university in 2021. During the course, the university was most of the time in a phase of emergency remote teaching. This resulted in an almost fully online learning setting, except for a few in-class tutorial sessions at the beginning of the lecture term. The other components of the course (including the lecture) were replaced by online formats (e.g., video recordings).

The course's main target group is bachelor students (typically, second to the third year), and it covers the fundamentals of IS with a particular focus on designing information systems. The course does not focus on the technical implementation of IS but focuses on the modeling and conceptualizing of software projects.

For many years, case studies have been an essential component of the course and the students have to work on three case studies each semester. However, previously the case studies were provided as text-based descriptions. During the field study, these were replaced by the digital case study and peer feedback app.

From a methodic point of view, the settings consist of three phases:

(1) Before the students got access to the app, the lecturer introduced the overall case study and peer feedback concept as part of the video-based lecture. Additionally, we included a video explaining the peer feedback process in the app. We also asked the students to answer a short survey on their prior knowledge (modeling skills, feedback skills).

(2) In the second phase, the students got access to the app. During this phase, the case studies were released successively. For each case study, a three weeks period was targeted. In the first week, the students got access to the video-based case study and had to work on their first submission. In the second week, the peer feedback process was conducted in which each student had to review two submissions of fellow students. In the third week, the students got access to the reviews from their fellow students and had to revise their own submissions. Afterward, the next case study was released.

(3) In the last phase, we asked the students to provide us feedback in a web-based survey and analyzed the aggregated and anonymized peer feedback reviews.

Results

In total, N=54 students of the course agreed to participate in the research activities, worked on the digital case studies, and took part in the peer feedback process. Approx. 93 % completed the three case studies and corresponding peer feedback processes.

Prior knowledge

In a short voluntary pre-survey among the students (N_{pre}=23), we asked them to self-estimate their modeling skills, their experience with digital modeling software as well as theire experience with giving feedback to peers. Interestingly, the self-estimations only very slight from $avg_{Modeling}$ = 2,78 (modeling skills), $avg_{Software}$ = 2,39 (modeling software), $avg_{Feedback}$ = 2,78 (giving feedback) on a Likert scale ranging from 1 (low) to 5 (high). The average values are below the scale mean values in all three cases.

The pre-survey results met our expectations as the course targets novice information system students who had passed two courses on fundamentals in computer science and IS before.

Aggregated data of the peer feedback process

During the case study and peer feedback process, the students uploaded approx. 160 submissions that were reviewed by peers. Approx. 310 reviews were completed on time and forwarded to fellow students. In total, 1191 annotations were added, and 270,000 characters were provided as written feedback.

After the review phase, the students got access to their personal reviews on their own submissions. This served as the basis for the subsequent revision and completion of the case study. Additionally, the students had the opportunity to rate the received feedback directly (helpful, neutral, and not helpful). Based on the students' rating, 59.13 % of the received reviews were helpful, 31.30 % were evaluated as neutral, and only 9,57 % were rated as not helpful.

Post survey results

Finally, we asked the participating students to provide us feedback at the end of the lecture term after completing all three case studies. To this end, we used a web-based questionnaire (7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree); N=21). In this post-survey, we focused on (1) the video-based case study design, (2) creating and (3) receiving reviews as part of the peer feedback process, as well as on (4) overall effects on learning.

The results visualized in Figure 5 suggest the success of the introduced digital case study and peer feedback process based on our developed app. First, the participating students stated that the video-based cases were useful (avg. 4.90), offer a practice-oriented case description (avg. 5.10), and are of good quality (avg. 5.29). As the average values of all measures related to the video-based case studies are above the scale's mean value, we rate this as a success.

The peer feedback process also received positive feedback from the students. They stated that creating reviews for fellow students supports the feedback givers' involvement with the learning contents (avg. 5.10) and encourages them to reflect on their own case study submission (avg. 5.14). In previous lecture terms, the students only had to work on three paper-based case studies without a peer review process. Nevertheless, this lecture term, the students stated that the time required for reviewing was appropriate (avg. 5.00). Also, getting feedback from peers was rated as useful (avg. 5.05) and encouraged to reflect (avg. 5.14). This is particularly interesting as the overall quality of the received reviews got the lowest rating in this survey, with an average value of 4.76.

Finally, the survey data on the overall effect of the introduced digital case-study and peer feedback process on learning suggest that our goal to improve the learning process could be reached. The students reported an increase in their modeling skills with an average value of 5.90. Additionally, their motivation to engage with modeling and the case studies was fostered (avg. 5.29), and their core skills increased as well (avg. 5.24). Thus, this indicates that our project's overall goal was reached according to the students' reports.

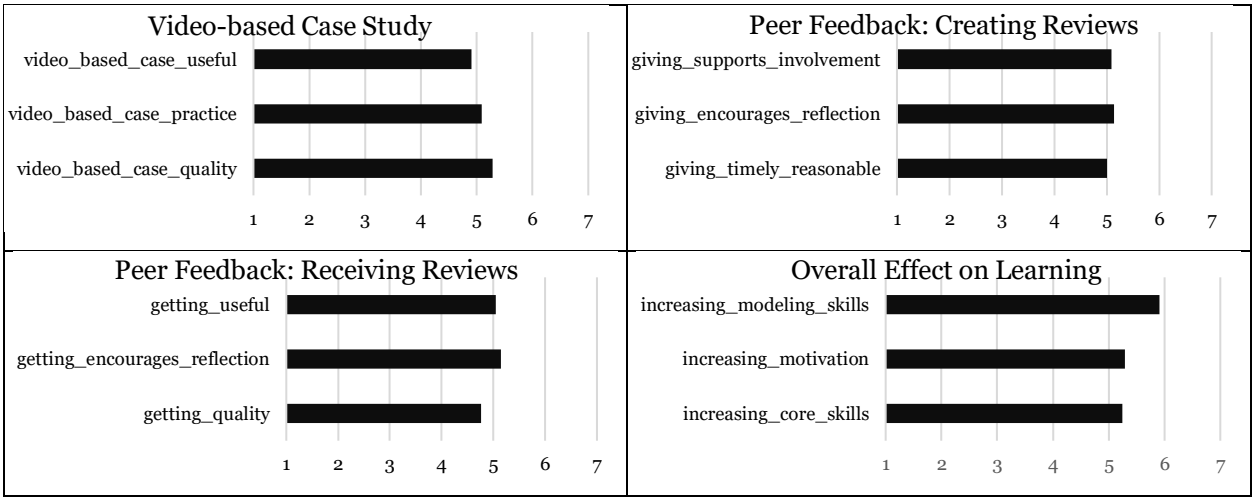

Figure 5. Overview of post survey results on (1) video-based case studies, (2) creating reviews, (3) receiving reviews, and (4) the overall effect on learning

Discussion and Conclusion

In this study, we focused on introducing a digital case study and peer feedback process in an IS course. Peer feedback is not a new concept in education, but it is rarely used in IS-related courses. Use cases, for instance

in the closely-related computer science field, can be found for using peer feedback for homework assignments in a software engingeering course (Berkling and Neubehler 2019) or for peer-based code review (Indriasari et al. 2020). Even though it is not a widely adopted learning concept in IS education yet, it has been used in other educational fields before. One of the most common learning settings for peer feedback are writing classes or other courses in which the evaluation of written assignments is helpful (e.g., Topping et al. 2000). In those settings textual input is usually the basis for the peer feedback process. However, in IS classes, written assignments are only one part that students need to work on. Particularly, when focusing on business process modeling or the (technical) conception of information systems, modeling is a key skill that students need to practice. By introducing our developed digital case study and peer feedback app in an IS class, we could show that our learning concept can successfully be applied in information systems education. The students' evaluations of the overall effect on their learning suggest positive results. By not using textual case study descriptions but relying on video-based cases according to the anchored instruction approach (The Cognition And Technology Group At Vanderbilt 1990), we could provide a learning setting that the students perceived as useful and practice-oriented.

Even though the peer feedback process was a new concept to the participating students and resulted in an additional effort compared to previous lecture terms, the students reported it to be useful. Most important – in our opinion – is that the students actually reported that both, creating and receiving peer reviews, encourage them to reflect on their modeling assignments. Thus, we conclude that the adapted learning concept might actually had impact on the students' learning processes.

Nevertheless, the quality of the reviews created during the peer feedback process is important to discuss. In the post-survey, the quality of the reviews received the lowest values across all items but still above the scale mean value. This is also reflected in the fact that (only) 59.13 % of all reviews were rated positive (see Subsection *Aggregated data of the peer feedback process*) where the others were rated as neutral or not helpful. To investigate this aspect further, we analyzed a random subsample of the reviews and found reviews of varying quality as well. As students always receive multiple reviews in our learning setting, the variations in quality can be balanced when a student receives a poor quality review and one high-quality review. Overall, it seems not to be too much of a problem as the overall effect of the process was rated positively. Nevertheless, possibilities for improving the review quality should further be investigated. For instance, improving the materials for instructing students how to provide helpful and constructive materials could be investigated.

As main findings of our study, we conclude: (1) Digital video-based case studies have the possibility to offer authentic and practice-oriented learning settings. This seems particularly desirable in IS study programs as the IS discipline – particularly when focusing on business process modeling – has a strong link to real-life situations in companies. Here, in particular, it seems important to us to provide students with realistic learning environments so that they can develop not only their specialist knowledge (i.e., modeling skills) but also get insights into pseudo-realistic challenges and problem settings of companies. (2) In our field setting, the developed app has proven to be a suitable tool for conducting peer feedback assessments in large-scale learning settings – even in times of emergency remote teaching during the COVID-19 situation. Although the developed app does not enable real-time collaboration of students, the peer feedback process has been proven to be an effective way of enabling collaborations of students by means of creating and receiving reviews. Based on this asynchronous and anonymous form of collaboration, the students improved and further developed their submissions. The surveyed effects on learning show that this form of collaboration is able to improve the students learning experience positively.

These main findings imply that video-based case studies and digital peer feedback processes can successfully be integrated into the curriculum of IS study programs. This seems particularly true when focusing on realistic learning settings and complex tasks.

Despite these first positive insights, further work is required to improve the learning setting as well as strengthen research. From a teaching point of view, improving the quality of student reviews seems desirable. Due to this, further effort by lecturers and teaching assistants is required to highlight the importance of valuable feedback and encourage the students to not only focus on improving their own skills but also be supportive by spending effort on providing feedback to fellow students. To achieve this, strategies for improving the quality should be developed and tested. One option to increase the quality of the reviews might be to remove the anonymity of the reviewers. This should be tested in future studies.

From a scientific point of view, the analysis of the digital case study and peer feedback process in a field setting has limitations as the field study was not set up in a controlled learning environment (like in a laboratory setting). Additionally, the analyses are mainly based on self-reports of participating students. Therefore, further investigations are needed to further research and validate our findings, for instance, in experimental settings with controlled learning environments. This might help to fully reveal the effects based not only on post-survey evaluation but on the actual learning outcomes.

Acknowledgments

We thank our teaching assistants for supporting the project, case study design, and video production. The project was partly funded by the Niedersächsisches Ministerium für Wissenschaft und Kultur.

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