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Using Slack for computer-mediated communication to support higher education students' peer interactions during Master's thesis seminar

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Abstract Our study contributes to the research on computer-mediated communication in higher education by experimenting a modern communication tool called Slack. In particular, we consider using Slack to support students' peer interactions during Master's thesis work. For this purpose, we designed a case study that was executed in a Master's thesis seminar course. During the course, all out-of-class communication was carried out by using Slack, instead of e-mails or learning management systems. After the course, we used a questionnaire to investigate how the students perceived Slack for asking for assistance, their intention to use Slack, and Slack's ease of use. Furthermore, the questionnaire asked feedback about challenges that the students found in slack. To examine the students' peer support in Slack, we analysed the messages in the course's public discussion channels. We investigated opportunities and challenges of Slack from instructional perspective by conducting an auto-ethnographic data collection. Our analysis revealed that the students perceived Slack as an easy-to-use communication tool with a low threshold of asking questions. The students also expressed high intentions to use Slack in the future. However, the students were worried of information overload in Slack, frustrated with decentralisation of communication tools in higher education, and cautious of using communication tools that are not officially supported by the university. The students' interactions were assigned to three categories: practical, technical, and thesis-related. Analysis of these categories revealed that the students were able to explicate and solve issues in Slack, but the issues were only related to practical and technical problems, instead of actual Master's thesis writing. The teacher perceived that Slack enhanced bi-directional communication with the students, but faced issues related to file management and user authentication. The results implicate that developing an alternative for Slack from educational premises could be more useful than a product that is not originally developed for pedagogical needs. Finally, we present recommendations that help educators to use Slack in their educational practices.

Keywords Slack; communication tools; computer-mediated communication; higher education; Master's thesis; peer support

1 Introduction

Typically, higher education courses include collaborative activities, such as group assignments, discussion tasks, or specific events to work on course exercises with peers. However, the Master's thesis is, in most cases, conducted alone and often perceived as a lonely and individual task. Despite this, previous studies about supporting students in Master's thesis process have concentrated on writing abilities (e.g. Delyser, 2003; Paltridge, 2002). Less attention has been paid to examine how students' peer interactions with computer-mediated communication could support the Master's thesis process.

This study considers computer-mediated communication in higher education by experimenting a modern communication tool, called Slack, to support students' Master's thesis work. Slack has become popular among software companies and academics and claimed to enhance communication and collaboration (Perkel, 2017; Gofine and Clark, 2017; Huang, 2017; Lin et al, 2016). These promises raise a question: could Slack serve as a platform for peer support in higher education when conducting Master's theses? Previous research on using computer-mediated communication to support Master's thesis process consist of works by Naghmeh Aghaee and co-authors (Aghaee and Keller, 2016; Aghaee et al, 2014; Aghaee, 2015). These studies consider supporting students with a learning support system, called SciPro. The system was developed according to the reasons why students contacted to a thesis support group (Aghaee, 2015). In the follow up study, they found that students perceived peer interactions with SciPro system useful to facilitate communication, enhance collaborative learning, and improve the quality of theses (Aghaee and Keller, 2016).

The context of the study is a Master thesis seminar course in the Faculty of Information Technology at the University of Jyväskylä, in Finland. The course is arranged two times a year to help participants in planning, conducting, and writing the Master's thesis. In addition, the course provides students with a venue to share experiences and discuss encountered problems. The out-of-class communication has been carried out with e-mails and a mailing list. Students are encouraged to ask for assistance by e-mails, when encountering problems, and the answers are shared in the mailing list.

The practical motivation of the study emerges from the issues that we have found to prevent students from sharing their problems and asking for help. First, too frequent e-mails in the mailing list have resulted in information overload and students have started to ignore these mails. Second, students have proposed that there is high social pressure to discuss with e-mails, because frequent posting to the course mailing list is easily considered as spamming.

To tackle these issues, we decided to replace the mailing list system with a more convenient tool to help students to discuss their Master's thesis work. We considered SciPro as a potential option, but unfortunately, we found that it is not freely available and 6 months trial license costs 6000 US dollars¹. Consequently, we

¹ SciPro - <https://www.sciprojects.com/buy/>, retrieved 24. October, 2017

ended up with experimenting Slack, because it was freely available and had gained a lot of attention. We soon found out that there are only few studies that examine the suitability of Slack, or similar tools, in education context. To overcome this deficiency, we decided to conduct this case study.

We address this topic by experimenting Slack as an only communication tool in the Master's thesis seminar course during autumn 2016. We investigate how the students perceive using Slack during the course, what challenges the students perceive in Slack, how the students interact in Slack, and what opportunities or challenges Slack has as an instructional tool.

The paper continues by describing, how Slack distinguishes from features that are integrated in many learning management systems: discussion boards, feedback system, and file sharing. Then, Section 3 presents the context of the study, the research questions, and how the data was collected and analysed to answer the questions. Finally, we present our findings to the research questions and discuss implications from both research and practical perspectives.

2 Slack in computer-mediated communication

Computer-mediated communication (CMC) refers to communication between people by means of computers and computer networks. CMC tools are used for content-related communication, task planning, and social support (Hrastinski, 2008). CMC tools can be categorised into two groups: asynchronous and synchronous (Hrastinski, 2008; Passig, 2013). Both asynchronous and synchronous CMC tools are commonly used in higher education, especially when most learning management systems have these tools integrated (Johnson, 2006; Murphy et al, 2011). Asynchronous tools, such as a discussion board, are used for discussing course topics and synchronous tools, such as a video call, are used to hold virtual office hours and to make group assignments (Branon and Essex, 2001; Portillo-Rodríguez et al, 2012; Hrastinski et al, 2010).

Recently, new kind of communication tools have emerged. A pioneering product is called Slack, launched in 2014. Slack has been rapidly adopted. Currently, Slack has over five million active users². Slack is especially popular among software companies, because it is claimed to help software teams to communicate and work more efficiently (Lin et al, 2016). Slack is also becoming popular among academics to organise research teams and enhance collaboration (Perkel, 2017; Gofine and Clark, 2017).

Slack was developed as a side-project in a gaming company. The employees needed to co-work in different locations and used Internet Relay Chat (IRC) for collaboration. Over the years, the employees developed their own IRC application, based on their game development project's needs. The application was called Slack, which is an acronym for Searchable Log of All Conversation and Knowledge. IRC, the communication protocol that Slack is built on, was developed in 1988 as a client-server program to enable synchronous text-based communication between multiple people. IRC client program connects to the IRC server which in turn is connected to all other servers around the world (Oikarinen and Reed,

² DMR reports, <http://expandedramblings.com>, retrieved 29. March, 2017

1993). Discussions in IRC are organised in channels, which serve as chat rooms devoted to different topics. These channels were moderated by individual users who were given "*channel operator*" status. Perhaps the most interesting phenomenon of IRC was that the channels enabled synchronous text-based communication for even thousands users³. As a consequence, IRC was a stepping stone technology, also used in many educational organisations, that facilitated the evolution of communities and subcultures of programmers, hackers, and computer gamers. The heredity of IRC is still present in Slack, as it can also be used with traditional text-based IRC-clients.

We argue that the most distinguishing feature of Slack is that it narrows the gap between asynchronous and synchronous communication in the same interface. Synchronous communication in Slack is done when both the sender and the receiver are online. In turn, asynchronous communication is done when the receiver is offline. In addition, asynchronous communication can transform into synchronous form and vice versa. Comparison to an asynchronous tool provides an example: if sending an e-mail to a receiver that happens to be online, there is no convenient way to continue the conversation synchronously with the same tool. In Slack, receivers can get push notifications to a mobile device, and the receiver can start real-time discussion using the mobile or desktop application, or web browser of any device. On the other hand, in Slack, synchronous communication can also continue in asynchronous form. During the interactions, the receiver can go offline and the sender continue discussing in another channel or with another person. When the receiver comes back, they can continue the same conversation. This kind of situation is difficult to imagine when using traditional synchronous tools like video call applications.

Huang (2017) argues that cloud computing provides Slack with message searching, file hosting, and screen sharing, why it outperforms instant messaging applications, such as WhatsApp and LINE. We want to specify this claim. First, both WhatsApp and LINE have already implemented message search function, so the search itself is not the thing. For example, WhatsApp has keyword search from messages, but ways to operate the results are limited: copy, delete, resend, and mark as favourite. In Slack, search can be narrowed to specific channels, members, dates, and files. Furthermore, search can be specified to include only messages that have, for example, links, pictures, or videos. The search results can be pinned to the channel topic, marked unread, or added with reminders. Second, Slack has file hosting features but it is not intended for hosting as such. Instead, Slack has integrations with file hosting services like Bitbucket, Github, Dropbox, and Google Drive, which enable powerful options for collaboration. For example, Google Drive is commonly used in education and through Slack integration the members can share, manage, and edit files and get updates about these changes. In addition, these integrations can be used to automate various tasks: version control, issue tracking, and monitoring development (Lin et al, 2016). Using these integrations could make many tasks between educators and students more straightforward. By getting rid of sending different versions of files, informing supervisors when the files have changed, or informing students that supervisor has given feedback on the files.

³ <http://irc.netsplit.de/networks/top100.php> retrieved 24.6.2017

Finally, when comparing to instant messengers, we add that Slack enables more seamless collaboration of a large number of people. The communication in WhatsApp, LINE, iMessage, or Facebook chat is normally between two people or a small group at a time. Even in the tools that are used for business purposes, such as Microsoft Lync and Skype for Business, the communication takes place in arranged online meetings. As an example, many open source projects have Slack environments where developers are free to join and some channels can have even thousands of members. In Slack, as it used to be in IRC, the channels serve as community for people who the topic concerns. Building digital communities, where students can give peer feedback and support each other, could have remarkable potential in facilitating learning. As pointed out by Huang (2017), when educators are considering communication tools, the evaluation should not consider only the applicability to learning activities, but also the potential to encourage students' interactions to support each other.

3 Case and method description

Case study research determines *"what is to be studied"* instead of the concrete methods to be used. The concept of case refers to a *"bounded system"*, a single entity with boundaries, of which we are particularly interested (Miles and Huberman, 1994; Stake, 2006; Merriam, 2009). Our case is bounded by the Master's thesis seminar course, where Slack was experimented with. According to Yin (2012, p.6), *"case study research involves systematic data collection and analysis procedures, and case study findings can be generalized to other situations through analytic (not statistical) generalization"*. Thus, the aim of this study is to provide comprehensive description of the case, collect data in multiple forms, and report the findings that help other researchers and educators to learn and contemplate the use of Slack in other contexts (Miles and Huberman, 1994; Yin, 2012). The methods itself consist of a questionnaire, a qualitative analysis of the students' interactions in the public channels, and teacher's auto-ethnographic report.

3.1 Study setting, course description, and participants

The study setting is the Faculty of Information Technology at the University of Jyväskylä, in Finland. The faculty provides education and research in Information Systems, Mathematical Information Technology, Cyber Security, Cognitive Sciences, and Educational Technology. The Master's thesis seminar course is targeted for the students who are carrying out Master of Science Degree in the faculty and starting to conduct the Master's thesis. The course is equivalent of 5 ECTS credits.

During the course, students are supposed learn how to conduct research and write a research report. Typically, students advance their theses through the stages of literature review and analysis, selection and formulation of the research method, and design of the constructive/empirical part of the thesis. The contents of the course is directly related to carrying out the Master's thesis work. Before the course, students should have selected a thesis topic together with their supervisor(s), and thus have supervisors assigned. In addition to attending the voluntary

lectures, the students must present and peer review their theses in the group sessions.

The course instantiation, in which the case study was carried out, lasted from 9 September to 16 December 2016. The course consisted of eight seminar lectures about typical tasks and problems that students confront during their thesis process (Table 1). The course material and tasks were provided in the course website. Every week, the students were given tasks that were related to the lecture topic and their personal thesis topic. The tasks were: illustrate your thesis statement as a figure, write an initial introduction, do a literature search, make an outline for the thesis, write about your research method, write how to use the chosen research method, and make a language review for one thesis. For students who could not participate in the lectures, there were extra tasks to compensate. It was possible to carry out the course from a distance by doing all the weekly and extra tasks and making a video presentation that was then reviewed by other distance students. When the seminar lectures were over, the students were presenting their thesis topics and giving feedback to each other.

Table 1 Course structure

Date	Lesson topic
5.9.2016	Introduction I: starting research process
12.9.2016	Introduction II: research questions, initial introduction
19.9.2016	Literature I: finding, evaluating and managing references
26.9.2016	Literature II: writing about literature, theories, assumptions
3.10.2016	Methodology I: qualitative, quantitative etc.
10.10.2016	Methodology II: data gathering, analysis
17.10.2016	Writing special: citation, references etc.
24.10.2016	End survey, thesis evaluation, maturity exam etc.
31.10.2016 - 12.12.2016	Presentations I - VII

In the beginning of the course, we utilised a pre-survey to gather information about course participants and to ask for the research consent. The questions were about seminar practicalities: initial Master's thesis topic, initial supervisors, and wishes for the course. We also asked if the students had used Slack before and what previous experiences they have in using it.

Initially, there were 37 signed up students to the course. However, six students dropped out in the early stage of the course and two students did not sign the research consent. Consequently, there were 29 students in the course, three females and 26 males. Four of the students were international students and carried out the course in English. Ten of the students had used Slack before, either in other courses or when working at a software company. The Master's thesis topics were related to software engineering, game development, computational data analysis, cyber security, and telecom networks. The teacher of the course (the first author) has a Master of Science in Computer Science and has graduated from the same university.

During the course, Slack was used for discussions and returning the course tasks. For these purposes, the following discussion channels were established: gen-

eral, weekly tasks, extra tasks, in-class tasks, presentations, and distant presentations. In addition, students could have private discussions with each other or with the teacher using direct messages. At the beginning of the course, some students were asking questions and sending tasks by e-mail and the teacher needed to remind them to use Slack.

3.2 Data collection and analysis

To collect and analyse the data, we framed the following research questions:

- RQ1: How the students perceive a) Slack for asking assistance, b) the intention to use Slack, and c) Slack's ease of use?
- RQ2: What challenges the students find in using Slack?
- RQ3: What interactions the students have in Slack during the Master's thesis seminar?
- RQ4: What opportunities or challenges Slack has from the teacher's perspective?

For the RQ1, we designed a research questionnaire with three 5-point Likert scale question sets to measure students' perceptions of using Slack. The constructs were: perception of asking assistance with Slack, intention to use Slack in the future, and Slack's ease of use. The first two constructs had five items and were adjusted from the Social Presence Questionnaire of Online Collaborative Learning (Tu, 2002; Picciano, 2002; Lin, 2004). The third construct, related to the students' beliefs that Slack is easy to use, had three items and was obtained from the study by Huang et al (2012). To answer the RQ2, the Likert scale questions were accompanied with open questions about perceived advantages or disadvantages of using Slack.

The questionnaire was developed with Webropol survey tools and sent by e-mail to all 29 students who participated in the course. 24 students responded to the questionnaire. Thus, the response rate to the questionnaire was 82.8%. All Likert scale questions were compulsory, so the total amount of responses was also 24 and the proportions are counted based on this ($n=24$). We combined the Likert type items, which we assume to measure three constructs, as three Likert scale variables (Boone and Boone, 2012; Allen and Seaman, 2007). As mentioned, the construct items are obtained from previous studies, but we also calculated the Cronbach's alphas (Bonett, 2002). However, due to the small sample size (24), internal consistency of the data cannot be verified. Before calculating means and standard deviations for the constructs, we changed "I don't know" answers as missing values and inverted the needed items. We also provide frequency distribution of the constructs as well as the frequencies of the individual items.

To answer the RQ3, we examined approximately seven hundred messages that were written in the public channels during the course. In the analysis, we used an analysis protocol from previous studies (Moore, 1989; Moore and Kearsley, 2011; Aghaee, 2015). First, all students' messages were extracted from the public channels. The excerpts were annotated based on the topic of discussion. Excerpts and annotations were analysed and assigned to categories. Finally, the categories, excerpts, and annotations were interpreted to provide answers to the research question.

For the RQ4, the teacher (the first author) made notes about organising the course using Slack. These notes were reflected with the second author. We discussed the notes from the instructional perspective, such as how convenient it was to add the students to Slack, to organise course tasks in Slack, or communicate with the students in Slack.

4 Results

4.1 Asking for assistance, intention to use, and ease of use

The students perceived Slack as a suitable platform to ask for assistance, had high intention to use Slack in the future, and found Slack easy to use (see Table 2). When looking the item frequencies (Table 3), 83% (22/24) of the students agreed it was possible to ask assistance from other students and 96% (23/24) agreed that it was possible to ask assistance from the teacher. Compared to e-mails, 75% (18/24) of the students perceived Slack more comfortable to ask questions from other students and 67% (16/24) to ask questions from the teacher. 79% (19/24) of the students preferred using Slack to discuss course related issues than a virtual learning environment. 92% (22/24) recommends Slack for the future seminars and 75% (18/24) prefers using Slack in other courses as well. When comparing Slack to other mediums, 83% (22/24) prefers Slack over e-mails, 79% (17/24) prefers Slack over Optima, and 67% (16/24) prefers Slack over Moodle. Finally, 92% (22/24) of the students think that Slack can provide clear guidance information, 92% (22/24) think that using Slack does not require too much time, and all of them (24/24) find learning to use Slack easy.

Table 2 Frequency distribution, mean, standard deviation and Cronbach's alpha (n=24).

	1	2	3	4	Mean	SD	α
Asking for assistance	5.0%	6.6%	48.3%	31.7%	3.16	.41	.82
Intention to use	0.8%	5.8%	47.5%	30.0%	3.27	.48	.62
Ease of use	0.0%	3.9%	56.6%	34.7%	3.30	.50	.83

scale: 1= strongly disagree , 2 = disagree, 3 = agree, 4 = strongly agree

These findings were apparent also in the students' open answers. The students described Slack's benefits when asking for assistance with three concepts: relaxed environment, instant communication, and information sharing. A student commented that "*[Slack has] a low threshold to ask small questions, which I would not dare to send by e-mail.*" This was further conceptualised as a relaxed environment: "*[Slack is] a relaxed environment to contact the teacher or other students.*" Furthermore, the benefits of the environment were referred as more open atmosphere: "*I feel that there is more open atmosphere in Slack, when comparing to platforms like Optima or Moodle.*" Instant communication was referred as a possibility to make questions and get answers quickly: "*[Slack provides] instant and informal interactions between teacher and other students.*" Another student compared Slack to e-mails: "*Unlike with emails, Slack feels more like an instant messenger and therefore when you message someone, there's a higher chance of getting a response*

Table 3 Item frequencies. Mode class is emphasised as bold (n=24).

	1	2	3	4
Asking for assistance				
Possible to ask for assistance from other students using Slack	0	0	14	6
Possible to ask for assistance from the teacher using Slack	0	0	8	15
Prefers Slack over e-mail to ask for assistance from other students	1	3	13	5
Prefers Slack over e-mail to ask for assistance from the teacher	0	4	9	7
Prefers to use Slack to discuss course related issues than a learning management system	2	1	14	5
Intention to use				
Recommends to use Slack in the future Master thesis seminars	0	0	16	6
Prefers to use Slack also in other courses	0	0	9	9
Prefers using Slack instead of e-mails in other courses	0	2	14	6
Prefers using Slack instead of Optima in other courses	0	3	11	6
Prefers using Slack instead of Moodle in other courses	1	2	7	9
Ease of use				
Slack can provide clear guidance information	0	2	16	6
The use of Slack does not require too much time	0	1	12	10
Learning to use Slack is easy	0	0	15	9

scale: 1= strongly disagree , 2 = disagree, 3 = agree, 4 = strongly agree

fast." Shared information was related to the possibility to share information about course related issues: *"Slack also makes the discussions visible to everyone so the info reaches everyone when issue is handled."*

When regarding the intention to use, some students noted that they would use Slack in other courses as well, if it would be possible: *"Currently, there aren't really courses that would use it, and as such it is only another service to visit, even if the actual usage of it would be a pleasant experience."* Another student well exemplified the intention to use: *"The only reason keeping Slack from being more useful seems to be the lack of use in my opinion. I feel like Slack would be way more active discussion channel if it was in use at wider range of courses/studies."*

The students conceptualised ease of use as an easy access using native applications or a browser, customisable notifications, and a good user interface. As a student commented: *"[Slack is] very easy for conversations as well, as you don't have to install extra software, and the application supports (I believe) several platforms."* Couple of students commented that they can adjust the notification settings, so they will get important announcements to phone: *"[Slack is] easy to use, a low threshold for asking questions, mobile client with customizable push settings."* Finally, the modern user interface, especially in mobile client, was mentioned several times: *"to my mind, [Slack has] very clean and responsive interface, very akin to Flowdock for example."*

4.2 Students' perceived challenges

Despite the previous positive findings, the students pointed out several challenges in using Slack in higher education context. These challenges can be summarised

to three concepts: information loss, decentralised policy of communication tools, and issues related to privacy and security.

As previously exemplified, the students appreciated the low threshold of asking for assistance. At the same time, the students worried about the same issue as with e-mails that important information is lost in the stream of less important messages: *"I checked Slack weekly, and saw some posts by teacher a bit late. I think that all official information (coming from teacher) should be sent via email."* To overcome this issue, a student commented that effective use of Slack *"requires good planning for different rooms for chat. Otherwise, if the teachers writes something important on Monday and then you log in on Thursday, the important message might get lost into bunch of other messages."*

The students brought up that they are frustrated of using different communication tools in every course: *"there is no norm for used chat application or software so if there are multiple courses going on at the same time and each want to use a different environment, it can be a total mess. Decentralisation of course communication is therefore the biggest problem."* This was related to a fact that some students are used to e-mails and prefer using them as main communication tools: *"there are also people who actually don't use real-time online conversations since they can cause pressure, and thus at least I would still keep email as an alternative"*. This was brought up also by another student: *"The greatest challenge in using Slack is that how to motivate students who are used to communicate with e-mails?"* A student proposed that the use of communication tools should be planned on a department level: *"[Slack] could be used as a central hub for several courses, with all of them conveniently in different channels"*.

The students brought up concerns related to security and privacy. A student pointed out that if universities cannot influence how the used communication tool is developed, it may cause problems in the future: *"compared to in-house systems the development of it might potentially veer towards a non-ideal route for university use"*. Another important remark was when using tools that are not controlled by universities, there is no certainty how securely, and for what purpose, the data is stored: *"[Slack] Requires a Slack account and service infrastructure that are not in the university's control. It is a service developed by Slack Technologies. As a "cloud based" service University of Jyväskylä might not have any access/rights to the Slack users data."*

4.3 Students' interactions

The students' interactions were assigned to three different categories: course practicalities, technical matters, and thesis-related matters. The interactions in the course practicalities category were related to timetables, returning the tasks, organising the presentations, and other studies. Technical interactions were about university networks, course website, printing, and Slack itself. Thesis-related category consisted of interactions related to writing the thesis, using academic search engines, and thesis-related course tasks. In addition, there were several less relevant interactions that were not assigned to any category, such as returning the tasks late or not being able to participate to a lesson.

A recurrent theme in the excerpts related to course practicalities (Table 4) is how the answers to the presented questions can benefit all course participants, such

Table 4 Interactions related to course practicalities

Date	Channel	Quote
8.9	General	S1: "Do we return the extra task to Slack or do we bring it to the next lecture? ... Oh, it was just for those who missed the lecture, nevermind", S2: "I think you can return them privately", T: "Yes, extra task can be send privately to me and it is compulsory only for those who missed the lecture"
29.9	General	S: "Is there going to be some kind of opponening in the seminar?", T: "Yes, we'll talk about that today"
3.10	General	S: "Do we have a lesson during the autumn break?", T: "Yes we have, officially we don't have autumn break in our university"
18.10	General	S1: "@student I have a plan to travel on that time(08.12.2016), could you please change my date to 05.12.2016 and my name spelling is wrong this time as well :D", S2: "Wrong recipient... you probably meant @teacher", S1: "Oops! Yes it was for @teacher", T: "Answered privately"
23.10	General	S: "I see my attendace only until week 5, can't see week 6", T: "I have only made the markings for weeks 1-5"
24.10	General	S1: "So how the opponening is done in practice?", T: "You mean that when there are topics in different areas?", S1: "If I change to another group?", T: "Opponening is made in groups, not 1-1, so it is not a problem", S1: "OK, thanks", S2: "What about English speaking", T: "English speaking are all in same group"
13.12	General	S1: "If I make the Maturity Exam next year, do I need to inform the administration?", T: "Good question. Honestly, I don't know. Better to send e-mail for the administration", S1: "I got the answer and you should inform them"
14.12	General	S1: "When the Maturity Exam needs to be made?", S2: "Before graduating.", T: "Exactly, preferably soon after returning the thesis."
12.9	Weekly tasks	S: "@teacher, still weekly task 2 missing?", T: "Yes, and still working on with today's class. I have 3h30min :)"
15.9	Extra tasks	S: "week2 extra assignment is really difficult one :(", T: "I know, but do not stress about it too much. It does not have to be a nice scientific text, but to prove me that you've read the material and thought about it."

as questions about returning tasks, autumn break, opponening seminar presentations, and Maturity Exam. The purpose of a mailing list is often similar. Teachers can reply to students' questions in mailing list to inform others as well. However, the interactions in mailing lists usually remains unidirectional, so teachers are providing information to students. The excerpt about Maturity Exam provides an example how Slack facilitated bidirectional communication: the teacher could not answer to the presented question and recommended the student to ask it from administration. Then, the student informed other students by delivering the correct answer from administration.

From the excerpts related to technical matters (Table 5), it can be seen that, in addition to asking questions, the students were providing information to each other. As an example, a student noticed that the university servers were malfunctioning and informed about this in the general channel, because this prevented students to return the tasks. The excerpts between students implicate how Slack served as a platform for peer support even without the teacher's active involvement.

From the excerpts related to thesis work, it can be seen that there was little meaningful conversation about conducting the thesis (Table 6). Even the relevant interactions (about research plan, article types, and thesis topic) were more asso-

Table 5 Interactions related to technical matters

Date	Channel	Quote
12.9	General	S: "Should the class page say 'inductive' instead of 'inclusive'?", T: "Going to fix typos etc. afterwards :)"
6.10	General	S: "Tip: this 'Participate events' page shows the topic for each week on the same page without the need to search for each one individually in the calendar view"
11.10	General	S1: "I heard a rumour that students in the seminar used to have free printing, is it anymore?", S2: "Back in the days there was no printing quota...", T: "Haven't heard about that, but you can ask your supervisors to print", S3: "Or you can go to assist some course -¿ staff status -¿ endless quota", S1: "Staff has endless quota? I already belong to this secret society :)"
18.10	General	S: "There is a problem with the university's NAS server so that's why jalava and halava are not usable. (The 'U: network drive' is not working)", T: "Ok, thanks a lot for the information"
18.10	General	S1: "Hi, where do I find the Topics-site? I don't see it at the Course's main site.", S2: "You can see the groups through the calendar in Korppi", S1: "Worked, thanks!", S2: "... or even easier by following the link titled 'participate events'"
27.9	Extra tasks	S: "I still cannot access those publications. I connected to the university network via VPN, I created an account on dl.acm.org using my university email, but the page still requires me to pay a lot of money for each and every PDF", T: "No, you don't need ACM account and you should not pay anything. When you are in VPN connection in Jyu network, the PDF files are available. If you are having problems, you can contact IT-services of the university"
5.9	Weekly tasks	S: "Actually this weekly tasks was not automatically joined. I had to do it manually", T: "Yea, there was something weird about that. Luckily it is easy to force invite people to the channels"

ciated with the course tasks than the actual thesis work. Based on the analysis, it is reasonable to summarise that the students supported each other in Slack by explicating and solving the confronted issues, but the issues were more about course practicalities and technical matters than actual thesis work.

Based on the analysis, we derive three main findings: Slack encouraged bi-directional communication, students provided information for each other, but the interactions did not consider issues that are meaningful for thesis work.

4.4 Opportunities and challenges from instructional perspective

Based on the notes and reflections of the teacher, there were three benefits: Slack enabled better time management, there was a possibility to shift from asynchronous to synchronous communication, and communication with students was more personal. When regarding challenges, the teacher found problematic Slack's informal status, inconvenient file management, and incompatible authentication with the university's user system.

Slack enabled better time management during the course, especially when comparing to e-mails. When the teacher received a message from a student, he could immediately read the notification and if the student's issue was urgent or not. This allowed the teacher to allocate time to answer all the presented questions at once. This benefit was somewhat similar to automatic filtering of course related

Table 6 Interactions related to thesis

Date	Channel	Quote
12.6	General	S1: "About correlations: http://www.tylervigen.com/spurious-correlations ", S2: "Classic! Proves the point well"
28.9	General	S: "Are we going to make a research plan for the Master's thesis in the seminar?", T: "Research plan is made always. Weekly tasks are part of making the research plan, which is presented in the final seminar."
18.9	Extra tasks	S: "Oh God... I'm glad I didn't decide to study philosophy after all...", T: "I think the problem with that chapter is that it tries to concern too many topics. These things make much more sense after reading a book or two. But I am looking forward to read your papers tomorrow"
25.9	Extra tasks	S: "what is a conference article? conference by definition is not an article?", T: "Basically the main venues for publishing scientific research are either journal articles or conference articles. From ACM 'browse the ACM publication' you can find either journal and conference articles."
7.10	Extra tasks	S1: "Lol. So the newest assignment is to find a conference that develops some methodology and to write a 1-2 page summary of it. I found so far two conferences about it and they're both 1 page long", S2: "Lucky u r", S1: "I know", S3: "What method is it then? Sounds kind of strange to me.", S1: "I don't remember. I didn't really read them. I just searched for the research methods and those were the first two links :)", T: "that is strange indeed. Typically methodological papers are really long, because new methods needs to be well argumented"
18.9	Weekly tasks	S: "Master's thesis topic still not confirmed, hopefully next week (It's a pity, because the tasks would be more useful, if I'd know my topic for sure). On Tuesday I'm meeting my supervisor", T: "Yes, therefore the intention is that people have topic when they come to seminar. On the other hand, quite often people do not, even I did'nt when I made my seminar."
6.10	Weekly tasks	S: "About task 5, I need to find a research method using the given links and then think how it could be used in my thesis, am I right?", T: "Yes, writing about research method may not be current for everyone, but it is already a good idea to start thinking about methods. So that's why we practice reporting 'imaginary' method use. Do I make myself clear?", S: "Yes, I think I can handle it."

e-mails to a folder, which are read when devoting time to course issues. However, because the questions in Slack were visible to other students as well, the students had sometimes resolved the issue by the time the teacher logged into Slack.

The possibility to shift from asynchronous to synchronous communication enabled more straightforward interactions with the students. For example, when the teacher sent a question to a student who was offline, the student received a notification, logged in, and started a conversation with the teacher. This was more convenient than writing an e-mail, waiting for answer, and then replying again. This scenario was especially true with some distant students, because the teacher needed to elaborate the tasks more in detail and verify that the distant students have understood them correctly.

The teacher found communicating with the students more personal than with e-mails. The students were sometimes informing that they are ill and cannot come to the lectures. One student was explaining his difficult situation with the current supervisor. One student was worried about finishing the course, because he had moved to another city.

The problem of not knowing if the students had read the important announcements remained. Even when Slack was intentionally used as an only communication tool, the teacher sometimes had an enticement to send e-mails. The teacher perceived that university members have certain conventions when using communication tools: important matters are normally communicated with e-mails, because other tools are considered as informal. In other words, the teacher sometimes questioned if it was enough to inform about course changes in Slack.

The teacher's initial plan was to use Git version control for organising the students' tasks. This proved out to be impossible due to the lack of students' skills to use Git and insufficient time to teach it. Consequently, the main technical issue was the poorly implemented file management feature. Files needed to be handled in the channel sidebar or a dedicated file archive page. By the time of the seminar, it was possible to see only the most recent files in the sidebar. In turn, in the file archive page, every assignment needed to be downloaded individually by first opening the file in a new browser tab and then manually downloading it.

Finally, the fact that students needed to make new user accounts caused practical problems. Some students never updated their profile information, even when they were asked to, and these students appeared only as usernames. Remembering, which username was assigned to which student, was frustrating. Another problem was that the students were first using random file names, which caused extra work for the teacher to track which file belongs to which student.

5 Discussion

The students perceived Slack as an easy-to-use communication tool with a low threshold to ask for assistance and expressed high intention to use Slack in the future. The low threshold to ask for assistance was related to the perceptions that Slack makes communication more instant, provides a relaxed environment, and enables better information sharing. Majority of the students preferred using Slack instead of e-mails, Optima, or Moodle. The students pointed out that they could use Slack in other courses as well, if it was possible. The questions regarding ease of use are originally from the Technology Acceptance Model (Huang, 2017; Kim et al, 2016; Huang et al, 2012). An interesting remark is that the students' wordings in the open answers were related to other aspects than mere ease of use. For example, ease of use was associated with the possibility to access Slack using a web browser or native mobile applications. This demonstrates that, even with this very mature construct, respondents can associate aspects that we researchers cannot anticipate. Thus, as Straub (2009) has stated, it is crucial to consider technology's cognitive, affective, and contextual aspects. In our study, we could see from the quantitative questions that the student perceived Slack as easy to use, but the reasons *why* this occurred emerged from the answers to the qualitative open questions.

The students expressed three major concerns for using Slack in higher education. First, the students suggested that without careful planning how Slack is used, and for what purpose, it suffers from the same problem as e-mails. If Slack channels fill from less relevant discussion, students get overwhelmed and stop following the channels. Furthermore, it becomes more difficult to a teacher to deliver important announcements.

Second, the students expressed frustration towards decentralisation of communication tools in the university. Teachers tend to prefer the tools they already know how to use. Consequently, students have to learn several tools and course communication is dispersed in various communication channels. The students proposed that a single communication tool, where all courses are arranged to channels, could be more convenient for them.

Third, the students were concerned of using commercial products that are not officially supported by the university. In the end, products like Slack are supposed to make profit and this can result as conflicting interests between universities and companies. Even when the companies promise that the basic use will always be free, they benefit from the data that is constructed in Slack. This calls for more attention towards students' privacy and rights when utilising commercial services (Romiszowski and Mason, 1996, p. 422). Furthermore, the students pointed out that if the development of the communication tool is out of university's control, there is no way to ensure that the developed features fulfill pedagogical needs.

Analysing the students' interactions revealed that the students were able to resolve encountered problems in Slack without the teacher's involvement. For example, the students helped each other when they had technical difficulties in returning the course tasks and provided information about course practicalities to each other. However, there were only few interactions that were meaningful for the course substance: conducting Master's thesis. This is in line with previous knowledge that facilitating high quality peer support requires clear instructions and active encouragement of students (Aghaee, 2015; Aghaee and Keller, 2016; Aghaee et al, 2014). This becomes even more crucial when using communication tools that are not originally intended for pedagogical needs. Thus, the communication tool itself, whether it is asynchronous, synchronous, or a combination of both, does not mean that students are able to support each other in their tasks. Building an infrastructure, where students support each other when confronting issues with Master's thesis, calls for careful pedagogical planning and development of an open and supportive communication culture.

From the instructional perspective, the most interesting finding was more bi-directional communication. The teacher was not only providing information in Slack, but also having conversations about course practicalities. The students also provided constructive feedback about course website, materials, and tasks to the teacher. The bi-directional communication realised especially when the teacher was communicating with the distant students: the teacher could discuss the course tasks and get feedback if the distant students had understood them correctly. However, Slack had some technical issues that made using it in the course more complicated: difficulties in organising the file management for returning the tasks and in organising the user authentication.

The main limitation of the study is related to general problematics of interpreting case study findings. Despite the fact that we got questionnaire responses from 24 students out of 29, these findings cannot be statistically generalised to a larger population. The students were purposefully chosen (by inviting to the study), the findings occurred in one course context, and the sample size is too small for statistical inference. However, the strength of the study lies in the methodological triangulation: if the study had relied merely on the three constructs in the quantitative questionnaire, we could only state that the students mostly agreed with the proposed claims. By collecting qualitative data with the questionnaire, analysing

the messages in Slack, and self-reflecting Slack from instructional perspective provided most of the previously presented findings.

Based on the study, we propose two research opportunities. One is related to unequal engagement in group work, known as freeriding (Zhang et al, 2017). The contributions of individual students in group work are normally evaluated with self-reflective reports or feedback discussions after the course. If the students would carry out the team work in Slack, it could provide teachers an outlook how students contribute to the group's task. This outlook could be utilised if students disagree each other's efforts. Moreover, this could provide an opportunity to shift the attention from evaluating final outcomes towards collaborative learning process.

Another opportunity is to develop an alternative for Slack, which would base on higher education needs. For example, there is an open source framework, called Mattermost ⁴, that could be tailored to better consider the educational context. By having control to the system's development, it would be easier to ensure that students' information is not used for commercial purposes, develop features for pedagogical needs, and to integrate user authentication with university's existing systems.

As a conclusion, this case study provided insights about the possibilities and issues when utilising Slack in higher education to support students in the Master's thesis work. The study revealed that students were able to support each other in practical issues, but not in conducting Master's thesis. This became obvious also after the study: the course's Slack environment is still in operation, to provide students with a possibility to discuss Master's thesis related problems after the course. Unfortunately, after several months, there has not been any additional discussions.

6 Recommendations for practice

Finally, we present some recommendations for utilising Slack in higher education:

- **Pay attention on rights and responsibilities:** Examine what features are free and what needs to be paid. Read the service provider's information how they secure the user information and other data.
- **Make pedagogical testing:** Pilot Slack with a small group before implementing it in an actual course. Plan how the discussion channels, task returning, and group discussions are carried out and make clear instructions for students.
- **Instruct authentication process:** Make instructions how students register to Slack and what e-mail address to use for registration. Ask students to use names that can be recognised. In Slack, it is also possible to change the interface to display full names instead of usernames.
- **Integrate file hosting:** Slack is not intended as a file hosting service, but it is possible to integrate common services like Dropbox, Google Drive, or Github to Slack.
- **Plan policy for tasks.** Conventions in file naming help to keep track on students' tasks. For example, surname with task number. Consider what type of files are returned. The benefit of using PDF files is that they can be opened

⁴ <https://about.mattermost.com>

in a browser. With other file types, it might be necessary to first download the file and then open with right application.

- **Emphasise important information:** Make dedicated channels for important announcements and add students with read-only rights. This way, the important messages are not lost in other messages. Students can be asked to enable push notifications from these channels to stay update about important matters.

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Statements on open data, ethics, and conflict of interest

The anonymised survey results are available for non-commercial purposes. Requests should be e-mailed to the authors with a clear statement of how the data will be used. The discussions in Slack are not made available.

The research was conducted in adherence to the guidelines of the Finnish Advisory Board on Research Integrity 2012. Research permission was collected from the students who participated in the Master thesis seminar and the participation in the study was completely voluntary.

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