

Mutual Development in Online Collaborative Processes

Three Case Studies of Artifact Co-creation at Different Levels of Participation

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Abstract

The following main research question guides this dissertation: “What characterizes the online collaborative processes in artifact co-creation where different participants interact and collaborate in further development of a software product or learning resource mediated by an online community?” The following sub-research questions are posed to delve deeply into the topic: 1) What are the implications of mutual development for interaction and collaboration in online communities? 2) What are the characteristics of mutual development that can be derived from a theoretical framework? 3) What methods are appropriate for collecting and analyzing empirical data on mutual development in small group collaboration and in mass collaboration? The first sub-research question is empirically motivated, the second theoretically motivated and the third is methodologically motivated. This dissertation draws upon and synthesizes the results of three case studies, with the common denominator and focus of study being to explore mutual development processes. Mutual development derives from Article 1 and is defined as how different participants (e.g. end-users and professional developers) interact and collaborate in further development of a software product (Articles 1 and 3) or learning resource (Article 2). In Articles 1 and 2, the method of template analysis was used to code and analyze the empirical data, specifically the content in the participants utterances in the online communities, as part of a qualitative approach. In Article 3, an integrative mixed methods approach was applied to integrate qualitative and quantitative data, combining Social Network Analysis (SNA) and Interaction Analysis (IA) to suit the context of mass collaboration. This dissertation makes three main contributions: 1) mutual development as an empirical contribution by exploring variations of the concept in three different case studies, 2) mutual development as a theoretical contribution by providing a new theoretical framework and 3) a methodological innovation by combining two different methods (SNA and IA). These contributions add to the research fields of End-User Development (EUD) and online communities by providing detailed empirical analyses of new constellations of interaction and collaboration between end-users, professional developers and champions in mutual development processes. This dissertation is one of few empirical studies that critically examines participation in Massive Open Educational Courses (MOOCs), and it provides a methodological contribution to the research fields of Computer-Supported Collaborative Learning (CSCL) at work and distance education. The author is employed by the Department of Education, Faculty of Educational Sciences, University of Oslo.

Norsk sammendrag

Hovedforskningsspørsmålet i avhandlingen er: “Hva karakteriserer samarbeidsprosessene i artifakt co-creation hvor ulike deltagere interagerer og samarbeider rundt videreutvikling av et software produkt eller en læringsressurs som er mediert av et online community? Følgende delforskningsspørsmål går dypere inn i dette temaet: 1) Hva er implikasjonene av mutual development for samarbeid i online communities? 2) Hva er karakteristikene ved mutual development som kan utledes fra et teoretisk rammeverk? 3) Hvilke metoder er hensiktsmessige for å samle inn og analysere data i små samarbeidsgrupper og i mass collaboration? Det første delforskningsspørsmålet er empirisk motivert, det andre er teoretisk motivert og det tredje er metodologisk motivert. Avhandlingen oppsummerer og syntetiserer resultater fra tre ulike case studier hvor fellesnevneren og gjenstand for analyse er utforskning av mutual development prosesser mellom ulike deltakere i videreutvikling av et software produkt eller en læringsressurs. I Artikkel 1 og 2 er template analyse benyttet som metode for å kode og analysere innholdet i deltagerens utsagn som en del av en kvalitativ tilnærming. Mixed methods ble anvendt i Artikkel 3 hvor både kvalitative og kvantitative data ble benyttet, bestående av en kombinasjon av sosial nettverksanalyse (SNA) og interaksjonsanalyse (IA). Dette fordi konteksten i Artikkel 3 er storskala interaksjon i form av mass collaboration. Avhandlingen har 3 hovedbidrag: 1) Mutual development som et empirisk bidrag ved å utforske variasjon av konseptet i tre ulike case studier, 2) Mutual development som et teoretisk bidrag ved å presentere et nytt teoretisk rammeverk og 3) Et metodologisk bidrag som kombinerer to ulike metoder (SNA og IA). Mutual development defineres i Artikkel 1 som hvordan ulike deltagere (for eksempel sluttbrukere, champions eller profesjonelle utviklere) samarbeider og interagerer i videreutvikling av et software produkt (Artikkel 1 og 3) eller en læringsressurs (Artikkel 2). Denne avhandlingen er et bidrag til forskning innenfor fagfeltet End-User Development (EUD) og online communities ved å presentere detaljerte empiriske analyser av nye konstellasjoner av interaksjon og samarbeid mellom sluttbrukere, profesjonelle utviklere og champions i mutual development prosesser. I tillegg er denne avhandlingen en av få empiriske studier som kritisk undersøker deltagelse i Massive Open Educational Courses (MOOCs), og avhandlingen gir et metodologisk bidrag til forskningsfeltet Computer-Supported Collaborative Learning (CSCL) på arbeidsplassen, og nettbasert undervisning. Forfatteren er ansatt på Institutt for pedagogikk ved det Utdanningsvitenskapelige fakultet, Universitetet i Oslo.

FOR OLEANDER, NATHANIEL AND EREMIAS

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PART I:
EXTENDED ABSTRACT

1. Introduction

Different ways of participating in online communities have become commonplace in the entrance to the social age. There is a move from using online communities as merely a means for distributing information to forming online communities of active contributors through content creation, such as in software product development processes. By pressuring manufacturers through online communities, end-users can easily request improved products and learning resources,¹ as well as suggest ideas for new features. Therefore, end-users not only provide input about the requirements for new features of a product or learning resource, but they are also becoming active participants in the software product or learning resource development processes. Our social worlds are gradually becoming increasingly digitalized, and as a consequence, social scientists need to find new methods to understand contemporary society, such as following people's social activities on the internet and through technologically mediated communication (Kozinets, 2010). In 2018, there were more than 4 billion users on the internet, accounting for 53% of the world's population, who were actively communicating with one another to express and deepen social alliances and share information, rather than just passively consuming published content (We Are Social, 2018). This dissertation explores the new relationships between end-users and professional developers in further development of a software product or between learners and course organizers in further development of a learning resource, that have emerged from the internet and other new forms of communication. Domain-expert users are experts in a specific domain, but they lack professional development skills (Costabile, Mussio, Parasiliti-Provenza & Piccinno, 2008). In this dissertation, the term *end-users* is used along the lines of Costabile et al. (2008) emphasizing that end-users have domain-expert knowledge.² This dissertation focuses on the ways in which participants with different backgrounds and skills interact and collaborate in online communities to further develop a software product or learning resource, which is defined as a type of artifact co-creation. This topic was chosen because it is a timely issue that has emerged with the advent of new media and web 2.0 technologies and is empowered by participation in online communities. The purpose of this dissertation is to investigate how the participants in online communities interact and collaborate through the co-creation of artifacts.

¹ In this dissertation, a learning resource is defined as the different learning elements and materials teachers and learners use or create, which can range from learning materials to exercises to the tools used in learning activities.

² This dissertation differentiates between "end users" and "participants". The notion of "end-users" refers to end-users and learners, whereas the notion of "participants" refers to everyone in the artifact co-creation process (end-users, learners, professional developers, course organizers and champions).

A paper published by the European Commission and its Directorate-General for Research and Innovation (2016) argues that because co-creation will be an area of wide scope and high impact, research is needed on co-creation and its implications for different domains. The paper supports facilitating research to promote understanding of co-creation, which would result in new economic and business models (European Commission, 2016).

The purpose of this research is to conduct exploratory case studies using empirical descriptions to illustrate and provide multiple perspectives on the focus of the studies. Exploratory research is characterized by open-ended research questions because the topics under investigation are new, and the existing literature offers no examples of empirical data from which to draw (Yin, 2014). In this dissertation, the research questions are concerned with empirical research, theoretical frameworks and research methods used in an emerging field. In exploratory research, it is important to provide detailed descriptions of the empirical phenomena studied to enable further research within the same topic. Moreover, the research should aim to create new theoretical frameworks and knowledge (Yin, 2014). Hence, the research in this dissertation is intended to be exploratory in two respects: 1) by illustrating existing theoretical frameworks and concepts with new data; 2) by developing a new theoretical framework based on the data to provide a nuanced understanding of the phenomena being studied. The review of current literature revealed, to the best of my understanding, the need for further exploration of a new theoretical framework to understand the processes of artifact co-creation in which different participants join forces in further development of a software product or learning resource, which is referred to as mutual development in this dissertation. An integrative mixed methods approach is used in this research (Bazeley, 2017), where an integration of Social Network Analysis (SNA) and Interaction Analysis (IA) is used to create and pilot a new methodological approach underlining the explorative aspects of this dissertation.

Furthermore, different levels of participation are considered in the analysis of processes of mutual development. The focus is on two levels: small group collaboration and mass collaboration. To analyze small datasets, IA was chosen as a suitable method due to its focus on the detailed analysis of social interactions and turn-taking among different participants (Jordan & Henderson, 1995). SNA and IA were integrated to analyze empirical data in the context of mass collaboration in Study 3. SNA is a useful method for analyzing social structures in large networks of participants (Scott, 2012), while IA was chosen to examine in depth some parts of the large dataset. In the future, it will be necessary to focus on

citizen empowerment by realizing the transformative power of innovation through co-creation in education and to concentrate on reforming learning processes by enabling active engagement with teachers (European Commission, 2016). Anticipating this need, Tapscott and Williams (2008) underlined that in the past, collaboration was conducted mainly on a small scale (e.g., relatives, friends, associates in households and workplaces), but this is changing with the increasing accessibility of information technologies facilitating mass collaboration, enabling millions of people to join forces in self-organized collaborations that produce dynamic new products and learning resources. Digital technologies enable greater access to learning and education resources (European Commission, 2016). In particular, they can foster the development of generic skills, such as problem solving, teamwork, collaborative work and digital skills, which enable contributions to social learning platforms (European Commission, 2016). Digitalization entails both challenges and opportunities, such as offering new possibilities for methodological innovation and the reformulation of existing theoretical frameworks. According to Cress and Fischer (2017), social software that connects humans and artifacts provides new opportunities for working and learning, which then necessitate new theoretical frameworks for understanding the strengths and weaknesses of mass collaboration. An implication of this for the dissertation is that the digitalization of society may result in new ways of interacting and collaborating in small group collaboration and in mass collaboration. Online communities in small and large scales are of central importance because they represent and mediate the interactions and collaboration that are the focus of this dissertation.

1.1 Aims and research questions

The main aim of this research is to investigate and explore interactions and collaborations between end-users and professional developers, and between learners and course organizers, in the co-creation of artifacts, which refers to further development of already existing products or learning resources that are mediated by an online community, that is, mutual development. The author completed an interdisciplinary master's program, Technology, Organization and Learning (TOOL), at the University of Oslo and continues this interdisciplinary interest in this dissertation by combining different research fields to analyze empirical data. The research fields are Computer-Supported Collaborative Learning (CSCL), End-User Development (EUD) and online communities. From the perspective of CSCL, ideas about co-creation as part of knowledge creation processes are reused, and from the perspective of EUD, focus is on different techniques of co-creation and adaptation during

further development of artifacts. In the research area of online communities focus is on how it mediates the artifact co-creation process.

The second aim of the dissertation is to identify the characteristics of artifact co-creation processes in differing contexts and among diverse sizes of groups. The analytical focus is on the interactions and collaborations between participants as they are mediated by online communities and the activities in which they participate. The setting is informal learning in a distributed workplace context (Articles 1 and 3) and in an informal educational context (Article 2).

The third aim is to explore the implications of the artifact co-creation processes that are mediated by online communities. The aim is not to investigate learning per se; instead, the dissertation analyses artifact co-creation processes in which different participants suggest and (to some extent) incorporate new features in an existing product or learning resource. This process is related to collaborative knowledge creation in workplaces (Moen, Mørch & Paavola, 2012; Paavola & Hakkarainen, 2005), which will be explained in section 3.2. The empirical data collected for this dissertation focus on how end-users and professional developers or learners and course organizers, co-create software products or learning resources that neither could have created alone.

The fourth aim is theory development by creating a new theoretical framework for exploring the phenomenon of mutual development between different participants in further development of a software product or learning resource. The theoretical concepts derived from the literature review and the conceptual framework provides the means for understanding mutual development and its variations across the three different case studies.

The fifth aim is to make a methodological contribution by proposing an approach to integrating SNA and IA and demonstrating it by application to the empirical data collected in the doctoral work on both small group collaboration and mass collaboration. To pursue these five aims, the following main research question is posed:

What characterizes the online collaborative processes in artifact co-creation where different participants interact and collaborate in further development of a software product or learning resource mediated by an online community?

The main research question links the three articles and guides the investigation by describing and discussing the phenomenon of artifact co-creation in terms of mutual development. The following sub-research questions address the aims and concretize the main research question:

1. What are the implications of mutual development for interaction and collaboration in online communities?
2. What characteristics of mutual development can be derived from a theoretical framework?
3. What methods are appropriate for collecting and analyzing empirical data on mutual development in small group collaboration and in mass collaboration?

Both the main research question and the sub-research questions are unique to this dissertation. To answer the main research question, the findings from all three studies (i.e., the three published articles) are compared in section 6.1. Sub-research question 1, which is empirically motivated, is addressed in sections 6.1 and in 6.2. Sub-research question 2, which is theoretically motivated, is addressed in section 6.3. Sub-research question 3, which is methodologically motivated, is answered in section 6.4.

1.2 Outline of the dissertation

This dissertation is divided into two parts. The first part is the extended abstract, which provides an interconnected framework for the individual studies that follow (three published articles), and is organized as follows:

Chapter 2 provides a review of literature from three relevant research fields: CSCL, EUD and online communities. The section is organized according to these three fields of research. Each subsection addresses one of these fields, beginning with a general introduction to the topic and then presenting two or three of the most relevant studies. Because the first article included in this dissertation was published in 2009, articles that were published between 2008 and 2017 were chosen to present previous research and review the literature on this topic. Chapter 3 presents the conceptual framework and derives a set of theoretical concepts that form the conceptual framework, which is subsequently used to inform the research design and to guide the analysis of the empirical data. Chapter 4 describes the methodology, including the research design and the methods used to collect, screen and analyze the empirical data. This dissertation strives for transparency when explaining the research design by emphasizing issues of reliability, validity, generalizability and research ethics. Chapter 5 provides a summary of the three articles included in this dissertation. Chapter 6 discusses and synthesizes the main findings reported in the three articles, emphasizing mutual development as a theoretical and empirical contribution of this dissertation. Next, empirical and theoretical contributions emerging from and across the three articles are discussed through the lens of the conceptual framework. Then, the integrative

mixed methods approach applied in Article 3 is presented as the methodological contribution of the dissertation. Finally, the implications of the dissertation are discussed. Chapter 7 presents the conclusions and limitations of the dissertation, reviews the research questions and suggests directions for further research.

Part 2, entitled “The Articles,” presents the three original full-length articles that comprise this dissertation. The published articles were based on earlier research, such as a master’s thesis (Andersen, 2008), a book chapter (Andersen & Mørch, 2013a), an EARLI SIG interest group contribution (Andersen, 2012a), conference proceedings (Andersen & Mørch, 2016b; Andersen & Mørch, 2013b; Andersen, 2012b; Andersen, 2012c; Andersen & Mørch, 2011) and a previous article (Mørch & Andersen, 2010). Although the articles comprising the dissertation are original, they build and expand on these prior publications. The three articles are presented chronologically in the order in which they were written:

Article I

Andersen, R. & Mørch, A. I. (2009). Mutual development: A case study in customer-initiated software product development. In *International Symposium on End-User Development* (pp. 31–49). Springer: Berlin, Heidelberg.

Article II

Andersen, R. & Ponti, M. (2014). Participatory pedagogy in an open educational course: Challenges and opportunities. *Distance Education*, 35(2), 234–249.

Article III

Andersen, R. & Mørch, A. I. (2016a). Mutual development in mass collaboration: Identifying interaction patterns in customer-initiated software product development. *Computers in Human Behavior*, 65, 77–91.

2. Review of Previous Research on Artifact Co-creation in Online

Communities

The purpose of this literature review is threefold: 1) summarize current literature in the selected research fields, 2) contextualize the case studies and 3) expose gaps in the current literature to identify needs for further research. This review provides background and context for the conceptual framework presented in the next chapter, which discusses artifact co-creation by describing the research fields from which the concepts stem, framing the main research question in doing so. The review narrows down focus by pointing at relevant research fields according to the main research question and sub-research questions, and subsequently the review has a contextualizing function by explaining and framing the theoretical concepts the conceptual framework consists of. Some of the concepts elaborated in

this section are used as part of the conceptual framework. This review is also used in the rest of the dissertation as a justification of the need for the research conducted in this dissertation by indicating that it attempts to uncover gaps in existing literature and prior research.

This dissertation is interdisciplinary, drawing on the research fields of CSCL, EUD and online communities. One reason for using three different research fields in combination is revealed when confronted with the empirical data. No single research field can explain all the facets of artifact co-creation apparent in the data, necessitating broadening the perspective of the dissertation and integrating different research fields and methods, even though this is not easy nor without problems. It is the classic challenge of interdisciplinary research: risking being too eclectically oriented or having insufficient space to go deep enough into each of the multiple perspectives. However, this dissertation tried to counteract this risk by selecting a few central theoretical concepts from each research field. Nevertheless, when simultaneously broadening one's perspective and narrowing the number of concepts used, nuances may be left out in some places and a risk of oversimplification may manifest in others. Despite this, it seems best to pursue interdisciplinarity and address the shortcoming of this approach by pointing out areas that require more in-depth research in future work due to the space limitations of a dissertation, to properly address them.

The intersection of CSCL, EUD and online communities define the research on which this dissertation builds and to which it contributes. The three research fields each highlight a different aspect of artifact co-creation, where different participants jointly co-create a shared artifact mediated through an online community, and as such are relevant for the dissertation. Taken together these research fields can, to the best of my knowledge, address central elements of artifact co-creation in online communities. The research field of CSCL is chosen due to its unit of analysis, emphasizing both small group collaboration and mass collaboration, its interest in massive open educational courses (MOOCs) and the use of SNA as a method for analyzing mass collaboration interactions. Next, the research field of EUD is chosen due to emphasizing how end-users act as active contributors in technological development processes and what type of changes they propose to software artifacts. Finally, online communities as a research field is chosen in order to contextualize and emphasize the special type of technology mediation that mediates the artifact co-creation processes online. This was also a natural choice since all three case studies take place in online communities. What these research fields have in common is that they take place in informal learning contexts,³ emphasize

³ CSCL is not primarily about informal learning, but in mass collaboration, it is a common setting.

interactions and collaborations that are geographically distributed over time and place⁴, concern end-users who can be characterized as active users, take the group (not individuals) as the unit of the analysis, and examine processes of co-creation of shared artifacts. The shared artifacts in this dissertation are: software artifacts (Studies 1⁵ and 3) and knowledge artifacts with focus on co-creation of tasks (Study 2). For reasons of space, this literature review does not examine the entire research fields of CSCL, EUD and online communities, but focuses on studies in the intersection of at least two of these research fields. In the beginning of the review process, Google Scholar was used to discover the most-cited researchers in the three different fields of research. One way of accomplishing this in Google Scholar is to look at the articles that appear in the search results and look at their statistics with regards to “cited by”, where the number reflects the amount of citations. Next, the journals in which the authors of the articles had published their research were used for a more refined search for other relevant articles. Finally, the references of these were examined to identify the origins of the ideas presented in the articles, and those references that were fruitful were further examined. This process was repeated until sufficient coverage of each field had been achieved (in terms of the number of articles of some importance). Google Scholar is not comprehensive, but it is a good starting point for finding the most-cited and important articles in a research field. To limit the number of articles to the most recent research, it was decided to focus on those articles published between 2008 and 2017. The publications included international journal articles, books, book chapters, proceedings and web sites. In addition to the Google Scholar searches, some specific journals were thoroughly scanned for articles relevant to addressing topics connected to the main research questions and sub-research questions. The inclusion criteria for those articles were as follows: a) empirical study, b) qualitative approach or mixed methods approach emphasizing the qualitative aspect, c) published from 2008–2017, d) mediated by an online community and e) published in English. To systematically screen and categorize the articles, an index card reference document was created in Excel with the categories described above. This organization facilitated identifying patterns across the articles. The following journals were searched:⁶ *International Journal of Computer-Supported Collaborative Learning*, *Computers & Education*, *Journal of Educational Computing Research* and *Journal of Distance*

⁴ CSCL also focuses on co-located settings.

⁵ Study 1 is reported in Article 1, Study 2 in Article 2 and Study 3 in Article 3. Each of the three articles constitutes a case study.

⁶ Searches were conducted in September 2017.

Education. These journals were selected as representative for the field of CSCL, based on reports of research studies that focused on the topics of MOOC, SNA and mass collaboration and due to their relevance to the research questions. When looking for studies focusing on MOOCs, the *Journal of Computers in Human Behavior* was searched. For example, 55 results appeared when searching the *Journal of Computers in Human Behavior* for the keyword “MOOC,” but initial screening determined that they were mainly quantitative studies. Next, using the keyword “MOOC” to search the *Journal of Distance Education* yielded 40 results. Although very few of them were qualitative empirical case studies, some studies were relevant, and they are reviewed in this chapter. Using the keyword “MOOC” in the *Journal of Computer-Supported Collaborative Learning* yielded only one result. In addition, the keywords “mass collaboration” and “social network analysis” were used to search all the aforementioned journals. When searching for relevant studies in the field of EUD, first all articles in all the available issues of the *International Symposium on End-User Development* (IS-EUD) were screened, followed by *Journal of Computer-Supported Cooperative Work* (CSCW), *Journal of Computers & Education* and the *Journal of Educational Computing Research* using the keywords “artifact co-creation,” “co-creation of products,” “co-creation of shared artifacts,” “collaborative product development in online communities” and “collaborative product development”. These journals were selected because they represent up-to-date research by central researchers who combine aspects of EUD and CSCL. When searching in Google Scholar with the term “online communities,” the most cited book that appears is *Online Communities: Designing Usability and Supporting Sociability* by Preece (2000). Next, when searching for relevant articles connected to online communities, all available articles in the proceedings of the *International Conference on Communities and Technologies* were screened using the keywords “online participation,” “online collaboration,” “online environment” and “online community.” This conference series was selected because it involves many central researchers in the topic of online communities and advanced technology mediation.⁷ The literature review presented in this chapter does not claim to be exhaustive. It is merely intended to provide insight into the current landscape of research on artifact co-creation mediated by online communities. The remaining portions of the chapter

⁷ The *Journal of Computer Mediated Communication* (JCMC) was not included in the review since the purpose of reviewing the field of online communities is to provide a background for understanding the setting of the studies in the dissertation. As mentioned in section 2.3.1, online communities is the “least important” of the three research fields included in the dissertation, since it only contextualizes the case studies, and is therefore also given the least space in this review. This necessitated a narrow focus on a few key articles, so the JCMC had to be excluded.

are divided into three parts, each reflecting one of the three research fields described above: CSCL, EUD and online communities. First, a general overview of each research field is provided. Second, several selected studies in each research field are reviewed. Finally, areas requiring further research are identified.

2.1 Co-located and distributed CSCL

CSCL, which is a branch of the learning sciences, studies the ways in which people can learn together with the help of a computer (Stahl, Koschmann & Suthers, 2006). CSCL is an interdisciplinary research field emphasizing how collaborative learning can enhance peer interaction and work in groups and facilitate the sharing and distribution of knowledge and expertise among community members when supported by technology (Lipponen, Hakkarainen & Paavola, 2004). A common definition of collaborative learning is a *situation* in which *two or more* people *learn* or attempt to learn something *together* (Dillenbourg, 1999). CSCL studies can be co-located or distributed.

2.1.1 Empirical studies on co-located CSCL

In studies on co-located CSCL, participants are in the same geographical location. One example of this is a study exploring how students at one school talk and reason when they are exposed to a set of categories that was taken from scientific discourse and built into a web-based discussion forum Future Learning Environment (FLE) (Ludvigsen & Mørch, 2003). According to a survey of empirical CSCL papers in seven leading journals, focusing on the methodologies of 33 studies published from 2005 to 2007, revealed that most were quantitative descriptive studies in classroom settings based on self-reports and questionnaires (Jeong & Hmelo-Silver, 2010). Stahl (2006) focused on how a small group of students constructed their shared experience by using a graphical referencing tool in coordination with text chats to achieve a group orientation to a mathematical object. Stahl (2006) defined *small group collaboration* as group cognition, involving small groups engaged in cooperative problem solving or collaborative knowledge building in which the distinctive processes occurring at the individual, small group and community levels of analysis interact with each other. Furberg, Kluge and Ludvigsen (2013) explored how students used science diagrams in a computer-based learning environment, emphasizing that students engaged with this scientific environment demonstrated self-directed accounts of learning in a collective setting in which it was possible for the students to disagree with, validate or elaborate the sketches and ideas. Stahl's and Furberg et al.'s studies are examples of co-located case studies in

CSCL, which emphasize how students in small group collaboration use technological tools as mediating artifacts to facilitate small group collaboration. Co-located CSCL is relevant to this dissertation in terms of how small group collaboration is mediated by an online community. It provides input to the conceptual framework and is a contrast to mass collaboration, which is a central topic in sub-research question 3 and the conceptual framework. However, the main focus of this dissertation is not on co-located CSCL but on distributed CSCL and informal learning contexts.

2.1.2 Empirical studies on distributed CSCL

Studies on distributed CSCL focus on the ways in which technology facilitates the sharing and creation of knowledge by groups of students who are not co-located (Resta & Laffierre, 2007). This section of the literature review considers three sub-themes that are important areas of research in distributed CSCL: MOOCs, mass collaboration and SNA. MOOCs and mass collaboration have become important themes in CSCL research (Cress, 2013; Ludvigsen, Law, Rose & Stahl, 2017). Distributed CSCL can be further divided into small-group and large-group distributed CSCL. An example of small group distributed CSCL was presented in a study by Mørch, Caruso, Hartley and Ludlow (2018) exploring different contexts teachers can create to promote collaborative learning in 3D virtual worlds. Some studies on large-group CSCL are reviewed below.

MOOC studies on CSCL

Rosé and Ferschke's (2016) conceptual article underlined the importance of researching technology-supported collaborative interaction based on learning on a large scale. Rosé and Ferschke (2016) recommended studying MOOCs, anticipating renewed interest in several areas, such as problem-based learning, team-based learning, collaborative reflection and spontaneous personalized mentoring, following in the footsteps of cMOOCs. MOOCs can be divided into xMOOCs and cMOOCs. xMOOCs resemble traditional online learning courses where video lessons are available online and can be accessed at any time. cMOOCs are more open than xMOOCs in several ways. They are essentially different because they enable the learner to be an active contributor to creating the course design, including the tasks, curriculum and learning resources. Summing up, in xMOOCs the course content is defined by course designers, whereas in cMOOCs also the students can participate in the generation of the content (Baggaley, 2013). MOOC is an emerging area of research in distributed CSCL. However, to the best of my knowledge, there are very few empirical case studies of MOOCs

from a CSCL perspective. Several published articles have described the phenomenon of MOOCs (Baggaley, 2013; Baturay, 2015), identified future research challenges (Fischer, 2014) and discussed the differences between cMOOCs and xMOOCs (García-Peñalvo, Fidalgo-Blanco & Sein-Echaluce, 2017). A recent study at the University of Oslo analyzed the first MOOC held at this university using a mixed methods approach (Singh & Mørch, 2018). Quantitative approaches investigating MOOCs include a survey that explored the factors affecting MOOC learner retention (Hone & El Said, 2016) and a study that provided insight into the recent developments of MOOCs and how they can be incorporated into high school curricula (Brahimi & Sarirete, 2015). Karnouskos (2017) argued that MOOCs could promote employee competence and innovation in industry. Formanek, Wenger, Buxner, Impey and Sonam (2017) provided insight into large-scale online peer assessment based on the results of an analysis of an astronomy MOOC. Other studies that have addressed learning in MOOCs have examined motivation and self-regulated learning (Littlejohn, Hood, Milligan & Mustain, 2016). In contrast, Knox points out how MOOCs that enable user-created content are difficult to use because the sheer volume of information can make users feel overwhelmed, and the user-created nature of this content may cause it to be interpreted as inappropriate or having a lower value than material created by organizers (Knox, 2014).

Walji, Deacon, Small and Czerniewicz (2016) studied learner engagement and learner interactions in two MOOCs, analyzing participants' responses to learning design choices and exploring how the allies of learners responded to the roles of educators and how individual learners interacted in the MOOCs. This study is relevant for the present dissertation because to the best of my knowledge, it is among the few empirical studies that have examined social practices in an MOOC. It is particularly relevant in connection to the notion of Zone of Proximal Development (ZPD) in the conceptual framework (Chapter 3), which provides a theoretical focus in Article 2. Furthermore, previous research on MOOCs addressed how online educational platforms enable masses of people to be part of peer learning on a large scale distributed over time and place. This type of research helped frame the main research question of this dissertation. Some MOOCs promote learners' active engagement by enabling them to be part of joint co-creation of course content, which has many similarities to the notion of artifact co-creation and is therefore also relevant to the dissertation, despite the potential shortcomings identified above (Knox, 2014).

Mass collaboration studies and distributed CSCL

The term *mass collaboration* emerged after the introduction of web 2.0 (Dabbagh & Kitsantas, 2012; McLoughlin & Lee, 2010) to describe a new kind of community that enables a large number of people to discuss, collaborate and exchange opinions in diverse ways. Mass collaboration can lead to a high number of participants who collectively share ideas, develop solutions and discuss alternatives while collaborating in online communities. Tapscott and Williams (2008) popularized the term *mass collaboration* and defined it as the way in which millions of people join forces in self-organized collaborations with the goal of dynamically producing new goods and services. Following this, they define mass collaboration as consisting of four ideas: 1) openness, 2) peering, 3) sharing and 4) acting globally (Tapscott & Williams, 2008). Mass collaboration has been criticized for lacking scientific foundations, and Elliott points out that a drawback of mass collaboration as described by Tapscott and Williams is the authors' almost exclusive focus on commercial applications instead of the underlying mechanisms and dynamics (Elliott, 2007). Other researchers have criticized their work and raised questions regarding the way Tapscott and Williams indiscriminately compare online brand communities to nonprofit virtual collectives, arguing for the mutual benefits of producers and consumers independent of the type of community (commercial enterprise versus nonprofit organization) (Dijck & Nieborg, 2009). A more recent definition of the term mass collaboration has been suggested in the context of education and the internet, and thus is of relevance to CSCL: "Mass collaboration is characterized by the large number of people being (mass) involved in it, the digital tools they use (web 2.0), and the digital products they create" (Cress, Jeong & Moskaliuk, 2016, p. 6).

Examples of mass collaboration processes include Wikipedia and MOOCs. Cress (2013) defined mass collaboration as a process that happens in the "wild" when people use web 2.0 tools (mainly outside educational systems), including activities in communities where the processes induce individual learning and thus demonstrate collective knowledge creation (Lipponen, Hakkarainen & Paavola, 2004). Given this, mass collaboration also can occur in instructional contexts when people interact while creating or referring to artifacts (Cress, 2013). All this implies that mass collaboration can occur in both formal and informal contexts, though this dissertation focuses on the latter. Mass collaboration has some general characteristics that define its activities: a) How users interact with digital tools and what kind of products they create are key parts of the interaction process in mass collaboration; b) there is an increasing amount of interrelatedness among the users; and c) mass collaboration in

education exhibits a special spirit that activates users and leads to emergent processes of collaboration (Cress et al., 2016).

Jeong and Hmelo-Silver (2010) provided a survey of previous research, identifying seven core affordances for technology in collaborative learning based on theories of collaborative learning and CSCL practices: 1) engaging in joint tasks, 2) communicating, 3) sharing resources, 4) engaging in productive collaborative learning processes, 5) engaging in co-construction, 6) monitoring and regulating collaborative learning and 7) finding and building groups and communities. Another novel study in this area identified the importance of understanding individual and collective processes as social interactions in knowledge communities by proposing a framework that distinguishes four types of joint interactions in online knowledge communities: attendance, coordination, cooperation and collaboration (the A3C framework) (Jeong, Cress, Moskaliuk & Kimmerle, 2017). These articles have in common the focus on design principles (i.e., affordances and interaction types) for CSCL environments based on prior empirical studies. This focus is relevant to the dissertation, which concerns mass collaboration as one context of artifact co-creation.

Roque, Rusk and Resnick (2016) explored how young people in the mass collaboration context of a Scratch online community created and programmed their own interactive media, animations and games, each of which represents a different style of collaboration. Compared to the other studies reviewed in this subsection, this study is particularly relevant because it is an empirical investigation of how participants in a mass collaboration context act as content creators in an online community. In general, the research topic of mass collaboration is a central one to this dissertation. The study by Roque et al. (2016) is also relevant to sub-research question 3, which focuses on appropriate methods for collecting and analyzing empirical data on mutual development in small group collaboration and in mass collaboration. Mass collaboration enables learners to become members of worldwide learning communities where they create and share digital products and learning resources that can be reused and further developed by others. Because of the novelty of this type of collaboration, new theoretical and methodological frameworks are needed to understand this question (Cress et al., 2016). Therefore, the next section reviews studies on SNA as an analytical method for collecting and analyzing empirical data on large scales like those of mass collaboration processes.

SNA studies on distributed CSCL research

In another area of research on distributed CSCL, SNA has been used to analyze social interactions that are mediated by online communities. SNA is a useful method for analyzing interaction of many participants, such as in online mass collaboration processes. Therefore, SNA is relevant to this dissertation, as it provides a method that can be used to analyze large-scale artifact co-creation as it appears in Study 3. SNA within the field of CSCL is an emerging research topic and not much research is conducted in this area yet. There is a brief amount of previous research of studies using SNA in an educational or CSCL setting. Researching a topic that has not been studied in detail has given me some challenges and opportunities. For example, one drawback of SNA is that it focuses on analyzing social relations at a general level (patterns of interaction). This implies that pure SNA studies leave out information about the content and context of participants' interactions, in other words, the qualitative aspects. However, this can be resolved by integrating several methods, which is the approach pursued in this dissertation.

Martínez, Dimitriadis, Gómez-Sánchez, Rubia-Avi, Jorrín-Abellán & Marcos (2006) applied a mixed methods approach in three different case studies to determine how to combine SNA with qualitative and quantitative analyses to study the participatory aspects of learning in CSCL contexts. Liu and Chen (2017) conducted a case study in which SNA was used as a method to investigate how elementary students formed teams and collaborated with peers in a digital storytelling context to create multimedia stories on a social network platform that provided multimedia authoring functions. These studies are relevant to the present dissertation because they use SNA as a method. Sub-research question 3 concerns methodology, focusing on developing a new methodological framework in which SNA is integrated with IA.

2.2 End-User Development (EUD)

EUD enables end-users to take ownership of problems by defining the technical and social conditions for their participation in design activities (Fischer, 2013). The European End-user Development Network of Excellence defined EUD as follows: “End-User Development can be defined as a set of methods, techniques, and tools that allow users of software systems, who are acting as non-professional software developers, at some point to create, modify or extend a software artifact” (Lieberman, Paternò, Klann & Wolf, 2006, p. 2).

EUD enables non-professional programmers to take part in software product development processes. One branch of EUD focuses on empowering end-users to become active contributors to further development of software products by providing them with tools and methods that enable them to do so (Fischer, 2010; Mørch, 1997a). For example, Mørch, Hansen Åsand and Ludvigsen's (2007) study found different tailored versions of a new software in use at a company, with end-user tailoring taking place locally through the collaboration of super users and the application coordinator. New technologies have created the potential to overcome the traditional separation between end-users and software developers by creating new environments that allow people without particular backgrounds in programming tools to develop and tailor their own applications (Costabile, 2008).

2.2.1 Empirical studies on EUD

In an empirical study by Dittrich and Vaucouleur (2008), the customization practices of standard systems were explored to determine how two Enterprise Resource Planning (ERP) systems were implemented and customized.⁸ Their findings showed that the most efficient way for companies to organize customization practices was to integrate them with the existing functionality in the ERP systems. Costabile et al.'s (2008) study of EUD focused on how to enable end-users to be active contributors and create changes to existing software. These authors adopted Fischer's (2010) meta-design approach in which the software continually evolves and end-users are enabled to perform development activities at use time, which allows them to shape the tools to fit their needs without the need for programming knowledge. Hence, these end-users were referred to as "unwitting programmers" (Costabile et al., 2008). The authors identified four types of end-users based on the results of the study: *power users*, *associated companies*, *registered guests* and *unregistered guests*. Draxler and Stevens (2011) researched active end-users as co-creators of content by focusing on how end-users acted as active contributors by tailoring their applications to suit the local context. Further, Mørch et al. (2017) conducted a case study that explored the relationship between EUD and learning in an online distance education program that trained in-service teachers in special education in Second Life, a 3D virtual world. Their conclusion was that when in-service teachers were allowed to personalize their learning activity it engaged them in the learning process, and that being situated in Second Life made the learning process more transparent and meaningful for the participants. Similarly, Grohn (2017) reported a case study of the online video game Minecraft that investigated value co-creation by end-users. The author stated that co-created

⁸ ERP is a business management software system used for organizing and collecting information in a company.

value was not only generated through a developer-to-gamer relationship but also in gamer-to-gamer relationships with the developer as facilitator. Finally, Jeppesen (2004) investigated the ways in which manufactures profited from facilitating processes of innovation in user communities and capturing the value of what was produced, which could be achieved by providing end-users with a modular platform that had additional tools to facilitate the development process. Jeppesen (2004) defined *modding* as the act by which users modify an existing hardware or software to perform a function that is not necessarily authorized (i.e., imagined or anticipated) by the original manufacturer.

In summary, a key finding of these studies is that end-users act as active contributors in software development by performing different types of tailoring activities (i.e., customizing, creating local adaptations or writing modifications as extensions of products). This finding is relevant to the dissertation because it demonstrates that end-users can become active participants in artifact co-creation processes. The studies reviewed in this section are related to the concepts of meta-design, user-driven innovation, co-configuration and modding, which are central terms in the conceptual framework of this dissertation. The research field of EUD in general relates to the main research question by emphasizing the role of including end-users in development processes, thereby provides a relevant dimension to the research, which tries to bridge the research fields of EUD and CSCL by looking at how they can complement each other. EUD focuses on active end-users and can augment CSCL, a perspective holding that artifacts can be changed through modification and further developed in collaboration with end-users. Conversely, CSCL can provide a learning perspective to EUD, focusing on how collaborative knowledge-creation processes may emerge during artifact co-creation. In summary, these research fields are complementary, implying they can be fruitfully combined.

2.3 Online communities and distributed collaboration

The term *online community* is used across different disciplines, often to describe the online interactions among different participants at a location specified by a uniform resource locator (URL). However, a plethora of different definitions exists. Rheingold (1993) provided the following early definition of virtual community: “*Virtual communities* are social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace” (Rheingold, 1993, p. 3).

It has been debated whether online communities can be considered virtual because they are real communities comprised of real people that communicate and sometimes act together. Subsequently, the more suitable term of *online communities* was proposed by Preece (2001):

I use the term 'online community' to mean any virtual social space where people come together to get and give information or support, to learn, or to find company. The community can be local, national, international, small, or large. I continue to use 'online community' because it is the most widely used term (Preece, 2001, p. 348).

Because the terms *Communities of Practice* (CoPs) and (to a lesser extent) *Communities of Interest* (CoIs) are central and established concepts in connection with online communities, they are defined briefly as follows. CoPs encompass members that are brought together by joining in common activities, sharing a joint enterprise and identity (Lave & Wenger, 1991). Learning in CoPs is viewed as a trajectory within a network in which newcomers enter the community from the periphery and move toward the center as their expertise develops, gradually becoming integrated and socialized in the community, a process known as legitimate peripheral participation (Lave & Wenger, 1991). The concept of CoPs has been criticized for its overemphasis on aspects of belongingness and membership (Fischer 2001; Gee, 2005). In online communities, members can participate in many ways and to varying degrees, which implies that it is not clear whether the notion of membership in the community is helpful (Gee, 2005). In contrast, CoIs bring together participants from different communities of practice, who are defined by their collective concern with solving a particular problem (Fischer, 2001). Participants in CoIs have a shared interest in framing and solving design problems, which is often more temporary than the activities of CoPs. The participants in a CoI come together based on a common interest in some field and they may end their activities when this endeavor has ended (Fischer, 2009). CoIs also differ from CoPs in that the former do not initially require participants to have a shared understanding of the task at hand. The task is gradually created and collaboratively developed by the participants, emerging in people's minds and in the external artifacts produced by the activity (Fischer, 2009). Therefore, CoIs characterize online communities in which the participants collaborate in solving self-experienced problems and issues, which is relevant in connection to the main research question where artifact co-creation is framed in an online community context.

2.3.1 Empirical studies on online communities of collaboration

Mansour and Askenäs (2011) reported a case study that examined how participants used a wiki⁹ to enable and support collaborative practices, such as gathering and sharing knowledge in a large multinational company. The study focused on the wiki's openness and its influence on knowledge collaboration and sharing in the workplace. An ethnographical study by Pongolini, Lundin and Svensson (2011) examined a community of technology experts in a global automotive manufacturing company to see how its members used information technology to communicate and collaborate in global virtual teams. Finally, Akoumianakis (2017) conducted a case study in the context of an online community in the tourism industry, focusing on how cross-organization and collaboration in building tourist vacation packages in a regional setting leveraged virtual alliances that emerged in the practice of collaboration, which is an enacted social accomplishment. These studies demonstrate the ways in which online communities can facilitate collaboration and social interaction. Their findings are relevant to this dissertation because the empirical research question addresses social interactions and collaborations in artifact co-creation processes that are mediated by online communities. Online communities are identified as a relevant research field in the review since it frames the context for all three studies, and the main research question. However, online communities as a research field are not as important or central as the fields of EUD and CSCL for this dissertation, and as a result are not covered in detail. EUD and CSCL are considered more important since they frame the research questions by drawing on theoretical concepts that are relevant to investigating the phenomenon of artifact co-creation.

2.4 Identifying needs for further research

This chapter has reviewed previous studies focusing on artifact co-creation between end-users and professional developers mediated by online communities, in which a common denominator is active participation and content creation by end-users. In reviewing previous studies on MOOCs in CSCL research, which relates to the study reported in Article 2, very few relevant studies were found. For example, most of the studies on MOOCs focused on xMOOCs that resembled traditional online video courses and provided few opportunities for interaction and collaboration in the online community. Thus, there are so far few empirical studies on MOOCs facilitating interaction and collaboration, that is, cMOOCs. The implications are that social practices in MOOCs, such as interaction and collaboration among

⁹ A wiki is a website that is collaboratively developed by a community enabling anyone to create and modify content.

participants enrolled in cMOOCs, remain an emergent area for further research. In searching for articles connected to mass collaboration, it became apparent that very few empirical studies examined in depth the processes that occur in mass collaboration mediated by online communities. Hence, there is also a need for further research in this area. In the search for studies that used SNA as part of a mixed methods approach in a CSCL context, it was found that little research has been conducted in this area. Furthermore, the search revealed that there is a lack of empirical studies investigating the social relations and patterns of interaction in large online communities by using SNA as a method in combination with qualitative methods. Most of the published SNA studies are strictly quantitative or concern a physical (face-to-face) world of interaction with no consideration of online settings. In the field of EUD, there is a lack of studies investigating the ways in which end-users take part in artifact co-creation in online communities and examining the implications of interactions and collaborations in this setting, and especially between end-users. Further, none of the selected articles focused on how online communities can facilitate and mediate artifact co-creation processes. In the next section, the conceptual framework of this dissertation, consisting of the theoretical concepts that are used to explore and interpret the empirical findings in Chapter 6, is presented.

3. Conceptual Framework

New approaches to learning are needed to understand and support practices in which people create or develop useful and reusable artifacts in collaboration (Moen, Mørch & Paavola, 2012). Artifact co-creation, which is the focus of the research presented in this dissertation, includes complex processes in which different participants actively engage in different phases to co-create a shared artifact. The interrelated and productive constellations range from end-users and professional developers (Study 1), learners and course organizers (Study 2) to end-users and champions and professional developers (Study 3). The role of the champion is between those of the end-user and the professional developer. This dissertation fine grains and nuances what occurs in these constellations of interaction and collaboration in artifact co-creation to reveal several layers of interaction, which reflects the purpose of this dissertation. Because of this complexity, a single theoretical perspective cannot be used to describe and analyze the phenomena investigated in this dissertation. Therefore, in this chapter, a conceptual framework is developed consisting of multiple theoretical concepts, each covering a different aspect of artifact co-creation. This framework will then be subject to empirical fine-graining and nuancing.

The first part of this chapter is organized according to four central concepts that frame the dissertation: 1) the sociocultural approach, 2) the focus on mediation, 3) the computer artifact and 4) the Zone of Proximal Development (ZPD). The notion of collaborative knowledge creation is then discussed, followed by the notion of user-driven innovation. Then, two concepts emphasizing different ways of enabling co-creation in software product development processes are explained: co-configuration and meta-design. The conceptual framework is then summarized by elaborating on the connections between all these concepts. Finally, critical reflections on the connection between the theoretical concepts and empirical data, and reflections on the nature of an interdisciplinary conceptual framework are presented.

3.1 A sociocultural approach to interaction and learning

In the sociocultural approach, learning is perceived as context bound, situated in social practices and mediated by symbolic and cultural artifacts. Hence, this approach emphasizes participation in different social practices (Säljö, 2006). This dissertation takes on the view that learning can be best understood as social interactions that are mediated by artifacts. The sociocultural perspective emphasizes that physical and intellectual artifacts mediate our reality (Säljö, 2006). However, different directions, definitions and understandings of the relationship between individual and social aspects of learning are weighted differently. According to Dysthe (2001), these different directions include cultural psychology (Bruner, 1990; Cole & Wertsch, 1996), activity theory (Engeström, 2009), socio-constructive approaches (Berger & Luckmann, 1966; Gergen, 1995), learning as participation in communities of practice (Lave & Wenger, 1991) and dialogism (Bakhtin, 1984; Holquist, 1990; Linell, 1999; Rommetveit, 1974). The sociocultural approach in this dissertation refers to a general approach with a set of common traits: *learning is situated, learning is fundamental social, learning is distributed, learning is mediated, the language is central in learning processes and learning is participating in communities of practice* (Dysthe, 2001). This dissertation follows along these lines by investigating the phenomenon of artifact co-creation based on the assumption of treating learning as social interactions mediated by online communities.

The three studies reported in this dissertation focus on the interaction and development that occurs among the participants. Hence, the focus is not on individual learning but on what emerges in the social interactions and collaborations that occur among participants with differing viewpoints and expertise, taking on a collective perspective. The sociocultural

perspective on learning and interaction serves as an overarching framework orienting my view on the world with regards to learning and knowledge. The focus here is on *mediation*, *artifacts* and *ZPD* because they are important in describing the mediation of the interaction and collaboration among participants in further development of an already existing software product or learning resource.

3.1.1 Mediation

The concept of mediation takes on different meanings in different research traditions. Taking on a sociocultural approach impacts how the notion of mediation is defined. In a sociocultural approach, it is believed that physical and intellectual (language) artifacts mediate actions in the world (Säljö, 2001). The word *mediate* implies that humans do not stand in direct, immediate and uninterpreted contact with the world (Säljö, 2001). We handle the world with the help of different physical and intellectual artifacts that are integrated parts of our social practices (Säljö, 2001). None of the articles in the dissertation defines the notion of mediation or addresses it explicitly since it is not in the foreground of analysis. Therefore the term is addressed and reflected upon in more detail in section 6.5.1. In the articles, it is taken for granted that the different online communities mediate the artifact co-creation processes by enabling interaction and collaboration.

In this section, *mediation* is defined and the view of this dissertation regarding it is discussed. Mediation as a notion is included in the wording of the main research question, which emphasizes that computer artifacts have a mediating role. When researchers use a microscope in chemistry, one cannot analyze these artifacts by themselves and then look at learning in isolation. More generally, if one wants to understand learning as being part of social practices, one needs to choose a broader unit of analysis that takes them both into account, i.e., investigate how humans' use of artifacts impacts the learning processes in social practices (Säljö, 2001). Mediation as defined by Vygotsky (1978) consists of two aspects: signs and tool. Signs are internally oriented and aimed at mastering oneself, whereas tools are externally oriented and aimed at mastering the external world (Vygotsky, 1978). Wertsch (1991) developed the concept further by stating that tools or signs mediate all human activity and that cultural mediation is central to both social interaction and mental development. Choosing mediated action as a unit of analysis requires a relational interpretation of mind whereby action takes place within a sociocultural context of human development (Wertsch, 1991; Wertsch & Rupert, 1993). The focus of analysis in mediation by signs has its roots in Bakhtinian thinking and focuses on how language and various psychological means and

processes mediate the internal processes of the individual (Wertsch, 1991). The dissertation focuses on mediation by tools, that is, on how online communities mediate interactions and collaborations among different participants in processes of artifact co-creation, and not on how language mediates these interactions and collaborations. The notion of mediated action is used as formulated by Vygotsky (1978), which focuses on cultural artifacts as the mediating artifacts. The focus of analysis in mediation by cultural artifacts is tools and how they mediate processes of interaction (Säljö, 2006). Vygotsky (1978) expresses that humans think by using tools, by which he means external tools in social practices that enable us to change psychological processes, similarly to how physical tools can change working processes. For example, a person who uses a calculator operates with numbers in a different way from a person who mentally calculates (Säljö, 2006). It should be noted that Säljö argues that it is not always possible to distinguish between physical and intellectual artifacts (Säljö, 2006 referring after Cole, 1996). For example, when using a discussion forum (in an online community) to suggest new ideas and features to a software product (as in Study 3), a physical tool (online community) is being used, but it presupposes knowledge of signs and conventions that are lingual and symbolic to interact in the discussion forum, pointing to how these aspects are intertwined. Therefore, the artifacts' physical and lingual aspects go hand in hand and continuously impact each other (Engeström, 1999). This dissertation follows the same position on mediation. It is not easy to distinguish between the computer artifacts' physically mediating the processes in the online communities that were studied and the intellectual or linguistic signs connected to the online communities. However, it should be underlined that the artifacts is used in a social and historical setting, which in some situations enables coming into contact with the historically developed ideas connected with the tools and the connection between the individual and the collective processes that allowed these ideas to develop over time (Säljö, 2006). In the research question, mediation is used in line with Vygotsky and his understanding of cultural mediation as being closely connected with the social practices in which an artifact (i.e. online community) is used. Mediation has the potential to transform and develop the process in which it takes part. It can be viewed as a transformative process rather than one that merely presents a before and after picture of the reality. Vygotsky (1978) further expresses that by using external artifacts and signs the whole structure in our psychological processes is reformulated in the same way a physical tool reformulates working processes. This statement underlines that when using external artifacts in a mediation process a transformation process may occur, and it may transform human

activity and the social practices. Summing up, the role of a mediating computer artifact needs to be analyzed in connection to the mediated activity in which it is being used, which is in line with a sociocultural approach to learning. Transformation is relevant for the studies in connection to the software product (Studies 1 and 3) and learning resource (Study 2), which are continually evolving as a result of the artifact co-creation process.

3.1.2 Computer artifact

The theoretical notion of artifact in this dissertation is inspired by the sociocultural perspective in the sense that a computer artifact (online community) in the studies mediates the artifact co-creation processes. To differentiate between artifact co-creation processes and the artifact that mediates these processes, I have chosen to use the phrase *computer artifact* instead of simply *artifact* to avoid confusion and to underline that I am referring to a technological (computer) tool, being the online communities in Studies 1, 2 and 3, as a mediating computer artifact. According to the sociocultural perspective, we as humans are indirectly in contact with the world, which means that actions are always mediated by tools and signs (Säljö, 2006), which can be physical (e.g., a computer) or intellectual (e.g., language), as described in the previous section (3.1.1). The main difference between a tool and a sign is how they orient human behavior by having different mediating functions: The tool's function is to serve as a conductor of human influence on the object of activity; it is externally oriented, and it must lead to changes in objects. On the other hand, a sign is a means of internal activity aimed at mastering oneself through learning; thus, the sign is internally oriented (Vygotsky, 1978). The division between signs and (material) tools is not clear-cut and can in some situations be blurred. For example, a map can be both a sign and a material tool (Vygotsky, 1978). The materiality of a map (e.g., paper) is a physical object that can be touched and exist independently whether it is used or not (Säljö, 2001). However, it is also a tool made of signs, language and symbols that require mental interpretation (Mifsud, 2012). Computers consist of both tools and signs. Within the field of educational research, one will often choose to place more weight on the sign aspects of computer artifacts (as in language use) and will not take advantage of their physicality (or material aspects) which is integrated with mediation (Conole, 2009). This is because when the theories of mediation were first developed, computer artifacts did not yet exist. The focus in this dissertation is on the artifact as a physical (and sign-based) tool, concretized by the different computer artifacts that mediate the artifact co-creation process. Artifacts are not passive objects in human interactions; rather, they incorporate human knowledge, meanings, conventions and insights

and therefore become something to interact with when acting as a result of development (Säljö, 2006 referring after Leontiev, 1978). Therefore, artifacts in a sociocultural perspective are always part of the mediating action, and they must be seen in connection with the activity of which they are part. Therefore, artifacts should be seen in the light of their social and historical character, which gives physical artifacts a broader base, going beyond being merely signs based or having psychological nature (Säljö, 2006). It is in combination with a thinking human being and the artifact that actions can be accomplished, implying that human knowledge and skills are connected with artifacts (Säljö, 2006). The concept of *artifact* as defined within a sociocultural approach is closely connected with the notion of mediation (previously described in section 3.1.1). From a sociocultural perspective, analysis of learning processes and the artifacts supporting it are tightly intertwined. Therefore, a broader analysis is needed to consider them both and investigate how humans' use of artifacts impacts learning processes in social practices (Säljö, 2001).¹⁰ The different online communities in Studies 1, 2 and 3 represent the computer artifacts that mediate the artifact co-creation processes. They are further elaborated in section 4.1.1. A common denominator among them is that they are computer-based artifacts, existing in a computer-mediated world. In summary, the term *computer artifact* is used to describe the online communities that mediate the artifact co-creation processes. In the main research question, the notion of *artifact co-creation* refers to an empirical phenomenon to be investigated, rather than the theoretical notion of a computer artifact that mediates the process.

3.1.3 Zone of Proximal Development (ZPD)

Vygotsky (1978) viewed intellectual development and learning as beginning with social activity and then becoming individual activity: The individual learns and develops in social settings with others. The transformation from an interpersonal process to an intrapersonal one is the result of a long series of developmental events (Vygotsky, 1978). The concept of ZPD as derived from Vygotsky (1978) was initially defined as the ways in which individuals move between different stages of development and their potential learning levels. This definition focuses mostly on individual activity in different learning contexts. Engeström (2009) extended this definition of ZPD to an expansive learning framework, implying that the focus

¹⁰ Artifacts and mediation are closely related, but they are described in separate sections to show the nuances within these concepts. The discussion (section 6.5.1) considers the implications of mutual development as mediated by a computer artifact, and there the concepts are treated in connection to each other.

of analysis is on several people learning collectively when ZPD is viewed not only as the everyday actions of the individuals but also as a historically new form of societal activity that can be collectively generated. ZPD includes aspects of what is referred to as a double bind, which indicates a type of aggravated contradiction that is potentially embedded in everyday actions (Engeström, 2009). In this definition, ZPD represents tensions or contradictions that can be observed in everyday situations. The double bind is a contradiction that demands new qualitative instruments for its resolution (Bateson, 1972; Engeström, 2009; 1987). In Article 2, ZPD is used as a theoretical lens to investigate a cMOOC in which learners and course organizers co-create tasks for the course content. In the next section, the distributed collaborative knowledge creation metaphor is presented to focus on the shared artifacts that are created in collaboration during interactions among participants with different backgrounds of knowledge.

3.2 Distributed collaborative knowledge creation

In this section, the focus is on the knowledge creation metaphor as presented by Paavola and Hakkarainen (2005), which represents collaboration through the creation of shared artifacts. This collaborative knowledge creation metaphor synthesizes the acquisition metaphor and the participation metaphor¹¹ (Sfard, 1998). Similar models exist, such as the dialogical learning approach (Paavola & Hakkarainen, 2014), but focus in this dissertation is on the knowledge creation metaphor, since it is closest to my research interests and also referred to in Article 3. The collaborative knowledge creation metaphor is relevant due to its focus on the transformative and innovative aspects on the collaborative knowledge creation processes. In this metaphor, learning is examined in terms of creating social structures and collaborative processes that support knowledge advancement and innovation by addressing the importance of generating new ideas and conceptual knowledge (Paavola & Hakkarainen, 2005). Paavola and Hakkarainen (2005) view learning as the collaborative creation of knowledge artifacts, which are shared artifacts that emerge from individual knowledge and interaction among learners. They study this type of CSCL in both educational institutions and workplaces. An example of an evolving artifact that is co-created and emerges through collaborative

¹¹ Sfard (1998) roughly made a distinction between two metaphors on learning, acquisition metaphor and participation metaphor, to clarify the differences between individual and cognitive aspects of learning processes. One example of the acquisition metaphor is how the mind work as a container for information waiting to be filled up with knowledge, on one hand; and the participation metaphor where, learning is perceived as a process of becoming a member of a community of practice, focusing on the increased mastery of the community's knowledge without a deliberate effort of any form of transformation, on the other (Paavola & Hakkarainen, 2005 referring after Sfard, 1998; Bereiter, 2002.).

interaction among learners is Wikipedia. A central aspect of the knowledge creation metaphor is that it presents both an individual and collective learning process that goes beyond the information initially available to the participants. This approach is relevant to this dissertation since it is a metaphor that specifically deals with the co-creation of artifacts, focusing on how they are developed collaboratively. *Collaborative knowledge creation* is a keyword in Article 3 and is briefly discussed there, but the article could have benefited from a more thorough discussion, which was not feasible because of space restrictions. Therefore, this will be discussed in this section to expand on Article 3. The articles in this dissertation point to a transformation by which a software product or learning resource in a cMOOC continuously evolves through collaborative interactions and efforts among participants. This transformation has similarities to the collaborative knowledge creation metaphor, which views learning as the collaborative creation of shared knowledge artifacts that emerge from learners' individual knowledge and interactions among learners (Mørch & Paavola, 2012; Paavola & Hakkarainen, 2005). On one hand, the metaphor parallels artifact co-creation with respect to its focus on the collective co-creation of artifacts and software product development processes that involve transformation or innovation in co-creation of new features for an existing artifact. On the other hand, the knowledge creation metaphor differs with regard to highlighting the individual learning process, which is beyond the scope of this dissertation. In all three studies, an online community mediates the interaction and collaboration, which follows the collaborative knowledge creation metaphor, emphasizing that artifacts mediate, anchor and direct collaboration in ways that are easy for the participants to handle (Paavola & Hakkarainen, 2005). Next, all three studies focus on learning as social interaction and collaboration in the co-creation of a shared artifact. In Article 3, for example, the end-users suggested a new feature (i.e., "add notification preferences that are product specific") that they wanted to include in the existing product. Through long-term interaction and collaboration in the online community among end-users, champions and professional developers, the feature was eventually developed and implemented in the general product and made available to all. This process resembles the collaborative knowledge creation metaphor in which learning occurs through creating social structures and collaborative processes in turn-taking and interactions in the mediated and common activities emerging around development of shared artifacts. These processes support knowledge advancement and innovation by focusing on creating shared artifacts, and therefore resulting in an outcome (Paavola & Hakkarainen, 2005). In its original form, the collaborative knowledge creation metaphor was aimed at small group

collaboration, whereas this dissertation expands its use by applying it as a theoretical lens to examine collaboration in the context of mass collaboration and takes it one step forward by scaling it up. The majority of CSCL research focuses on the group as a unit of analysis as well as small group collaboration. Stahl, Law, Cress and Ludvigsen (2014) stated that the primary focus of CSCL research should be on the relationships among processes at several levels of analysis, such as individual students, small groups and classrooms or communities. With the increasing growth of online communities, in which up to thousands of participants interact and collaborate, it has become necessary to scale up and take larger constellations of people who interact into consideration as well. In Articles 2 and 3, the foci of the analyses are large groups of participants who interact and collaborate in further development of software products. However, neither of the aforementioned concepts in this chapter focus on who initiates or drives the collaborative processes forward. The next section presents the concept of user-driven innovation to address the need of scrutinizing who is initiating and driving the processes forward, thereby complementing these approaches. In user-driven innovation, the end-users drive the development forward.

3.3 User-driven innovation

User-driven innovation is a phenomenon in which users are active contributors, further developing products or learning resources for a community of users. User-driven innovation as presented by von Hippel (2005) is included in the conceptual framework of this dissertation because it has a slightly different focus from the previous mentioned concepts in the conceptual framework, providing a concept to understand aspects of how end-users are included as the drivers in artifact co-creation processes. As active contributors the users drive the product development process forward together with the manufacturer (von Hippel, 2005). Von Hippel (2005) studied user-driven innovation, emphasizing that integrating active users in a company's product development processes is of great importance because it can lead to innovation processes. Subsequently, von Hippel (2005) introduced a method for identifying sources of innovation by following lead users, who are inventors of a product, feature or idea that is picked up and transformed into a product innovation by a manufacturer or an early adopter of the new innovation. User-driven innovation is also a theoretical concept concerning how end-users contribute to the development process (von Hippel, 2005). This concept is used in all three articles presented in this dissertation. Articles 1 and 3 examine pathways commonly traversed as user innovations being transformed into general products. In Article 2, user-driven innovation is used to demonstrate that participants in an online

educational course engage in the co-creation of tasks for the course content.

The private-collective model of innovation represents a two-fold conceptual framework for understanding user-driven innovation that involves integrating two models of production in order to create public goods through private funding: 1) The private model focuses on private investment whereby innovators gain a financial return from an innovation, such as through intellectual property; 2) the collective action innovation model explains how under conditions of market failure, innovators collaborate to produce a public good (von Hippel & Von Krogh, 2003). The private-collective model, being a framework for understanding user-driven innovation, suggests a relationship between different participants in a joint development process in which both private and collective elements are apparent in the process of creating public goods. When these processes are successful, the products that are initiated and co-created by end-users are adopted by the manufacturers and sold as part of the general products. Nevertheless, this model lacks a fine-grained explanation of what occurs in such processes, starting with individual contributions toward a new product becoming included in a freely available collective product. This dissertation interprets the private-collective model as an aggregation model, which means that it combines small pieces of development and accumulates them into a new and freely available product. This interpretation implies the absence of a political decision-making process where a filtering of ideas for how to develop the product further where categories such as “potential development,” “will be developed” or “not going to happen” are not apparent. In processes of artifact co-creation, there is a selection process that determines the ideas that are considered in the “General development” process. Therefore, another theoretical notion to account for this aspect is needed in the conceptual framework. The concept of user-driven innovation does not include the ways in which end-users participate (e.g., with what tools and in what activities). In the next section, co-configuration and meta-design are presented as specific techniques for including end-users in product development processes.

3.4 Co-configuration and meta-design

A common aspect of all three studies is that participants are active, engaged and actively put forward ideas about further development of a software product or learning resource. This section discusses the ways in which end-users are enabled to co-create content in processes of artifact co-creation.

3.4.1 Co-configuration

Co-configuration is a concept for understanding the collaboration between end-users and professional developers in further development of a software product during various stages of continuous product development. Co-configuration is a notion that was first proposed by Victor and Boynton, who defined it as a new historical type of work and collaboration in which products continuously change according to customer needs (Victor & Boynton, 1998). Engeström (2004) takes this notion one step further by placing it within an expansive learning framework emphasizing that during collaboration among consumers and producers, the product is often reconfigured and customized. According to Engeström's framework, co-configuration within an expansive learning framework can be characterized by the following features (Engeström, 2004): a) It is transformative learning that radically broadens the shared objects of work by means of explicitly objectified and articulated novel tools; b) it is horizontal and dialogical learning that creates knowledge and transforms the activity by crossing boundaries and tying knots between activity systems in divided multi-organizational terrains; and c) it is subterranean learning, implying actions of spatial transition and movement, repetition, stabilization, destabilization and embodiment. The notion of co-configuration as defined by Victor and Boynton (1998) has some shortcomings, e.g., it is not explicit what roles customers have (are they doing development alone or in collaboration with other customers), and it also emphasizes that a company must go through certain given stages of historical work to accomplish co-configuration work, which is questionable since artifact co-creation processes often are complex and cannot easily be predicted to follow a certain pattern. Co-configuration is used as a theoretical lens in Articles 1 and 3 and is explained in the articles, using Engeström's definition of co-configuration. By using different techniques in socio-technical systems, end-users who are not necessarily skilled programmers actively participate in software development settings by contributing in a technological manner. End-users in Study 3 drive the development forward by creating local hacks and workarounds on their own and sharing ideas about how to further develop the software product, even though they are not employed as professional programmers in the company.

3.4.2 Meta-design

Meta-design is defined as a set of techniques and processes that enable end-users to act as designers and active contributors, which allows them to create new knowledge rather than restricting them to the consumption of existing knowledge (Fischer, 2010). The main aim of meta-design is to enable end-users who are not programmers to participate in modifying and

creating design environments during use time. Fischer distinguishes between use time and design time, the former being when customers can tailor the product themselves and the latter being development conducted by professional developers (Fischer, 2003). Meta-design is characterized by the following: 1) It contributes to ongoing product development by integrating professional and end-user development; 2) it permits users to create extensions and customizations of already existing products; 3) it shifts control from designers to users; and 4) it provides a useful framework for the design process (Fischer, 2003). In Articles 1, 2 and 3, meta-design helps focus on how end-users are active content co-creators in online communities. Meta-design facilitates the inclusion in technology development processes of end-users and contributors with domain expertise who are not skilled programmers. The Seeding, Evolutionary growth and Reseeding (SER) process model (Fischer & Ostwald, 2002), which is a theoretical concept used in Article 1, is a conceptual framework that supports meta-design. In meta-design, end-users are provided with a framework that enables them to alter already existing products at a rather late stage in the development process, during use time. The empirical data in Article 3 shows how end-users participate in all phases of the artifact co-creation process, ranging from initiating further development of the software product by contributing with a new idea for how to develop the product, to the later stages where the product idea is implemented in a general product and made available to all. Therefore, another concept highlighting the possibility of participating in development processes at all stages is needed.

Two other relevant terms that emphasize end-users as content creators are *collaborative tailoring* and *cultures of participation*. Both of these notions imply direct contributions by participants without the involvement of professional developers, implying that end-users can therefore be part of the development process at several stages. *Collaborative tailoring* is used to analyze how end-users collaborate in tailoring products without the involvement of the company's professional developers (Kahler, 2001). Article 3 investigates collaborative tailoring in large groups of up to thousands of users who interact through online communities. *Cultures of participation* refers to the contexts of the artifact co-creation processes in Articles 1, 2 and 3. A major objective of cultures of participation is to attract a large number of contributors (Fischer, 2010). Cultures of participation emphasize the potential of "the unfinished" and underline that design problems are never completely solved and need to remain open and fluid to accommodate changes in the user environment. Such cultures can be characterized as being in a state of "perpetual beta," that is, in an always-open

and continually evolving system (Fischer, 2010). Some examples of environments that are created by cultures of participation facilitating design, long-term development and contributions by participants are Wikipedia, YouTube, SketchUp and PatientsLikeMe (Fischer, 2011).

3.5 Connection between the concepts

This section presents the theory-driven concepts that are used to understand mutual development as discussed in Chapter 6. Furthermore, this section provides a fundament for Table 5, to be presented in Chapter 6, which describes different characteristics of mutual development. To highlight the complex and multifaceted processes that occur in artifact co-creation, this section emphasizes different theoretical concepts that comprise the conceptual framework of the dissertation. These concepts are derived from both the literature review and the described conceptual framework above. The concepts are selected because they are complementary despite their slightly different perspectives, and they are relevant for analyzing processes of artifact co-creation. This dissertation's view on the world with regard to learning and knowledge is based on a *sociocultural approach to learning and interaction* (Dysthe, 2001; Säljö, 2006). In examining this perspective, the dissertation draws on the notions of *mediation* and *artifact* as defined by Säljö (2001, 2006), Vygotsky (1978) and Wertsch (1991). These are key notions in describing the mediation that occurs during interaction and collaboration among participants in further development of a software product or learning resource. These concepts are integrated in the notion of a mediating computer artifact as a theoretical term describing mediation in the processes of artifact co-creation. Next, *ZPD* (Engeström, 2009; Vygotsky, 1978) describes how participants move between different stages of development. Their potential learning level (ZPD) is also an important aspect of the conceptual framework. These three concepts (mediation, artifact and ZPD) are chosen as central to this dissertation because they are relevant according to the main research question.

Next, mass collaboration is included in the conceptual framework because it is central to sub-research question 3, which asks for a context for understanding artifact co-creation in large groups of people. *Mass collaboration* is one type of collaboration, and it is included in the conceptual framework because it can be useful in scrutinizing how masses of people collectively share ideas, interact, discuss and collaborate in online communities (Cress, 2013; Tapscott & Williams, 2008). *User-driven innovation*, which refers to how end-users initiate further development of a product (von Hippel, 2005) complements the other concepts

described in this section by emphasizing how end-users can be the source of the *idea initiative*. User-driven innovation is included to put focus on how end-users are driving these collective processes forward. *Meta-design* (Fischer, 2010) is a technique used to facilitate inclusion of end-users who are not skilled programmers to act as contributors and enable them to be part of technology development processes. *Meta-design* limits the participation by end-users to further development of an already existing product. Another central concept is *modding*, in which end-users can participate and co-create content at any point during the development process. However, modding does not encompass collaboration between participants (Jeppesen, 2004). *Co-configuration* refers to collaboration between end-users and professional developers in further development of a software product during various stages of continuous product development (Engeström, 2004; Victor & Boynton, 1998). *Collaborative tailoring* (Kahler, 2001) highlights interaction processes between end-users when they collaborate in creating local workarounds and adaptations to a software product without the direct involvement of professional developers. The four latter terms describe how end-users participate in product development processes through different *interaction processes*. *Cultures of Participation* refers to the settings and contexts of these interaction processes (Fischer, 2011), indicating that a product is a *continually evolving artifact* (Fischer, 2010; Mørch et al., 2017). The collaborative knowledge creation metaphor and the notion user-driven innovation are examples of different *trajectories of idea implementation*. They elaborate the characteristics of the artifact co-creation process from beginning to end. These two approaches are generalized to different *trajectories of idea implementation*.

3.6 Critical reflections

This section will contain critical reflections on the connection between theoretical concepts and the empirical data. When combining different theoretical concepts into a conceptual framework, there is a danger that some of the concepts have latent tensions, for example with regards to having different epistemological origins. In general, epistemology can be defined as a branch of philosophy concerned with the nature and scope of knowledge. In other words, epistemology is a systematic consideration of knowing: when knowledge is valid, what counts as truth, how knowledge is constructed and how it becomes to be known and shared (Packer & Gioechea, 2000). This dissertation adopts a sociocultural perspective, described in section 3.1, as its epistemological point of view. However, there is not a single agreed-upon definition of a sociocultural approach, but rather different branches and directions exist (see section 3.1). This dissertation follow along the lines of Dysthe (2001) and take on a broad view of a

sociocultural approach to learning that characterizes it by following traits: learning as situated, learning is fundamentally social, learning is distributed, learning is mediated, language is central in learning processes and learning is participating in communities of practice. Other common denominators in the different concepts include their focuses on learning as social interaction and transformation and on the joint co-creation of artifacts.

This dissertation has a process focus, exploring the emerging social processes, in interactions and collaborations in the artifact co-creation processes. One can view learning in conjunction with the social interaction occurring in parallel with the co-creation of artifacts. In this way, artifact co-creation can help shed light on the physical aspects on the learning process, which is connected to the debate contributed to by different participants in order to modify or further develop a software product.

Finding a conceptual framework to combine different and complex theoretical concepts was challenging, but it was necessary because none of the theories alone would be able to shed light on the artifact co-creation processes that were examined in the three studies. The knowledge creation metaphor is partially incompatible with the sociocultural approach because it builds on three different approaches to learning (Paavola & Hakkarainen, 2005): a) knowledge building (Bereiter, 2002), b) organizational knowledge creation (Nonaka & Takeuchi, 1995) and c) expansive learning (Engeström, 1999). In other words, the knowledge creation metaphor consists of elements originating from three different theoretical frameworks which could be seen as a tension. This tension is resolved by explicitly stating that the focus in using the knowledge creation metaphor is on the aspects that align with a sociocultural approach: i.e., by seeing learning as a process of knowledge creation, concentrating on mediated processes in which common objects of activity are developed collaboratively (Paavola & Hakkarainen, 2005). According to Paavola & Hakkarainen (2005), the notion of a common focus of activity and the shared artifacts of the knowledge creation metaphor help shed light on central aspects of the empirical data: i.e. to see knowledge advancement in the creation of shared artifacts.

Analyzing processes, such as artifact co-creation, in which up to hundreds to thousands of participants are collaborating in a distributed setting is demanding and requires an interdisciplinary framework to sufficiently understand what is going on. In arguing for this, the dissertation strives to cover a broad range of relevant topics, ranging from unit of analysis (small group to mass collaboration) and details of collaboration processes during different phases of development, to the power connected with social relationships and the roles the

different participants have in artifact co-creation. In hindsight, there may be useful concepts that have been left out and could be areas for future research.

The concepts forming the conceptual framework have in common that they in different ways promote process aspects of artifact co-creation. However, one can criticize the dissertation's conceptual framework for not using the full version of the theoretical concepts as defined by the originating authors. I aimed to stay as close to the original definitions as possible. However, when conducting an exploratory study of a complex phenomenon, it is not always the case that the theoretical concepts and empirical data will perfectly match. As a result, the concepts have been appropriated to apply them for underlining important process aspects and nuances of the phenomena under investigation. This dissertation is first of all empirically driven, striving for careful empirical analysis and aiming to consider all the empirical nuances of the phenomenon of artifact co-creation. Focus of the dissertation is empirical processes that emerge through artifact co-creation of a software product (Studies 1 and 3) or learning resource (Study 2) in online communities. As a result, the focus is not on traditional product development processes per se, since this dissertation is not concerned with a product focus, but a process focus. This process focus has implications for how the theoretical concepts have been selected and applied. For example, in Article 1 the notion of meta-design is used to foreground the processes of the ways in which end-users are enabled to be part of a development process during artifact co-creation, such as by submitting suggestions for new features to be added to an already existing software product. In one sense, the notion of meta-design forfeits how it is a framework for enabling non-technical skilled persons to contribute in development processes. On the other hand, the empirical data in Articles 1 and 3 reflect that the end-users are considered domain experts and are in some sense experienced users. In this way, it is a tension in using the theoretical concept of meta-design as a lens on the empirical data. However, in this setting it is important to underscore that the end-users are identified as non-technical skilled users since they are not employed as professional developers in the company. Therefore, they cannot be expected to write program code in the same way as professional developers do and are defined as non-technical participants. This aligns with the notion of meta-design as enabling non-technical end-users to become active users in artifact co-creation processes. In hindsight, Article 1 could have benefited from a more precise explanation of my take on the notion of meta-design and how I apply it.

In Articles 1 and 2, the notion of co-configuration is explicitly used to analyze the

interactions and collaborations between involved participants, emphasizing the continuous relationship of reciprocated exchange between customers and producers implicating active customer involvement (Engeström, 2009). Similarly to meta-design, the focus with co-configuration is on the process, meaning choosing to focus on aspects of the concept as defined by Engeström (Engeström, 2009), which also has a process orientation. In Articles 1 and 3, empirical extracts show a relationship between end-users and professional developers by which end-users suggest ideas for new features that are taken up and sometimes implemented by the company, making it available in a new release of the products. This process is a continuous one in which end-users drive the development forward by sending feature requests to the company.

3.6.1 Limitations of an interdisciplinary approach

This dissertation and the articles it is comprised of are the result of interdisciplinary work. This means that a range of different concepts and methods originating in multiple fields are used to highlight the complex phenomenon of artifact co-creation. One of the threats to interdisciplinary research is conceptual confusion (Benson, 1982). To overcome the challenge of conceptual confusion, connections between the theoretical concepts used in the conceptual framework are created by trying to take into account the epistemology, sociocultural perspective, embedded in the theoretical notions and to the best of my knowledge making sure they are not conflicting. Another challenge with an interdisciplinary dissertation is that they tend to trade intellectual rigor for relevance (Benson, 1982). When choosing to conduct an interdisciplinary approach, the dilemma between using a concept in its original sense (as defined by its author) compared to using it to put light on several aspects of a research object to gain a broader understanding of it, must be weighed against each other. This is at the root of the challenges of the dissertation and is also reflected in the articles: There is not enough space to thoroughly discuss, apply and use the theoretical concepts in terms of their own premises, and as a result, the concepts may have been used in a more subjective manner. This dissertation attempts to overcome this dilemma by choosing concepts that have some common denominators, such as a process orientation and focus on artifact co-creation and were relevant and useful for analyzing the empirical data. Cress et al. (2016) argue that one can profit from “manifold approaches” by integrating multifaceted concepts and theories when analyzing a complex phenomenon. Such an approach likely also applies to analyzing interaction and collaboration in online communities, particularly in unpacking artifact co-creation with using the concept of mutual development, to which this dissertation contributes

with a new concept. To accomplish this, the dissertation uses an interdisciplinary approach to capture what is occurring in the complex dynamics defining mutual development in small group and mass collaboration.

4. Research Design and Methods

This chapter discusses methodological issues. First, the choice of research design is elaborated, including the case study approach, the qualitative approach and the mixed methods approach. Next, an overview of the dissertation's studies and methods¹² is presented followed by selection criteria for the case studies and participants. Subsequently, an overview of methods used during data collection, screening and analysis is presented. Then, the methods used during data collection and screening are elaborated in detail. This includes presenting the methods of interviews and focus groups, virtual ethnography and template analysis. Following this, the methods used to analyze the data, SNA and IA, are described. Finally, reflections regarding the research credibility of the dissertation are presented, including its reliability, validity, generalizability and research ethics.

4.1 Research design

The research questions guided the process of choosing what research design and methods to use in the different studies. Kozinets (2010) advised that the research method should be able to provide data that answer the research question. In Studies 1 and 2, a qualitative approach was employed. In Study 3, SNA and IA were integrated as part of an integrative mixed methods research design. This is in line with a methodological bricolage: an effort to integrate qualitative and quantitative methods that involves employing a mixed methods strategy to balance multiple data sources not according to whether they are qualitative or quantitative, but according to whether the information they provide adds depth or breadth to the overall picture (Bazeley, 2017). A researcher acts as a "bricoleur" when he or she gathers any relevant information that becomes available when collecting data from multiple sources and synthesizes it to interpret the results (Bazeley, 2017). The purpose of choosing an integrative mixed methods research design in Study 3 is in line with the aims of an exploratory case study: to examine, illustrate, nuance and interpret the phenomena under study, artifact co-creation, by integrating different data sources. Greene et al. (1989) describe *the purpose* of a research study as triangulation, complementarity, development, initiation or expansion instead

¹² I use a broad understanding of "methods" in this dissertation, including both methods and techniques used in the case studies to collect, screen and analyze empirical data.

of listing the methods used. They emphasized the need to scrutinize the purpose of the study beyond examining the methods applied. The underlying rationale for mixed methods research is that several methods may provide a richer multidimensional understanding of the phenomena to be studied (Bazeley, 2017).

4.1.1 A case study approach

The studies presented in the three articles in this dissertation use a case study approach with the goal of trying to gain an understanding of what was actually going on in the different cases by scrutinizing the how, what and why of each case. In a case study, the basic idea is that one case is examined in detail using whatever methods are conducive to developing as full an understanding of the case as possible (Silverman, 2005). As mentioned in the introduction, all case studies are exploratory, opening up for detailed empirical descriptions and nuanced interpretations of the phenomenon under study. Exploratory case studies provide several perspectives on their objects of study, and they often debate the value of further investigations of certain hypotheses or propositions (Yin, 2014). Further, Silverman distinguishes three types of factors that should be clarified in a case study: the boundaries, the unit of analysis and the limited research problem (Silverman, 2005). The unit of analysis and the research questions (the limited research problem) of this dissertation are presented in Table 2 with an overview of the studies. The empirical setting and context for the case studies is a central boundary identifying the case study approach and they are therefore explained below.

Three online communities are the empirical settings for the case studies in this dissertation (reported on in Articles 1, 2 and 3).¹³ These communities mediate the artifact co-creation process. Case study 1 was conducted at a middle sized software company selling project planning tools to the oil and gas industry. The company consisted of two geographically dispersed offices, one in Oslo and one in Stavanger. In case study 1, the online community that mediates the interaction between end-users and professional developers is a Customer Relationship Management (CRM) tool and a new web 2.0 platform that was created as part of a research project called KP-Lab (Moen, Mørch & Paavola, 2012). The platform aims at increasing and facilitating online communication and interaction with customers by providing them with a web-based issue-tracking system through which end-users can send improvement requests directly to the company via the platform. The term CRM emerged in the information technology community in the mid-1990s to describe technology-based

¹³ Screenshots of the online communities are presented in the articles.

customer solutions (Payne & Frow, 2005), though there is no common or generally accepted definition of CRM (Winer, 2001). Payne and Frow (2005) defined it as a strategic approach to creating improved shareholder value through the development of appropriate relationships with key customers and customer segments to create profitable, long-term relationships with them and other key participants. Parvatiyar and Sheth (2001) defined CRM as a comprehensive strategy and the process of acquiring, retaining and partnering with selective customers to create superior value for both the company and the customer. These definitions have in common that they view CRM as a technological tool for organizing and systemizing customer information to meet the overall (business) goal of increasing revenue for the organization. My interest in CRM concerns how this technology can enable and enhance active customer interaction, which to a large extent has been overlooked in previous work. One trend in contemporary CRM research examines “social CRM,” in which end-users actively interact with company employees as well as provide input to the system. The concept of social CRM recently emerged to describe how social media can be used in CRM activities (Reinhold & Rainer, 2012). Social CRM is defined as the ways in which technological systems facilitate users with limited computing skills in sharing information across multiple sites (Monteiro et al., 2013). Baird and Parasnis (2011) recognized that instead of managing customers, the role of a business should be to facilitate collaborative experiences and dialog across the two communities (developer and user) that are valued by customers. Social CRM suggests a means of shifting from classical, “one-to-many” customer communication toward individualized “one-to-one” interaction with many customers. One approach has been to tailor campaigns, mailings and postings to target groups (Rainer & Reinhold, 2012). Little research has examined how companies integrate online communities with their existing CRM systems to ensure that these systems do not become just another information channels, but instead support interaction and artifact co-creation with customers. The context for case study 2 is a peer-to-peer educational platform (P2PU), which is a community offering MOOCs to a large number of learners in different subject topics. The structures in the P2PU community reflect the open nature of MOOCs in that the courses offered by P2PU do not require any formal education to attend, but the learners must register before they can follow the course and participate online. Study 2 focuses on one specific cMOOC, called the Javascript course, being in an informal educational context. The Javascript course is a course for enhancing programming skills in Javascript. The course provides different features for interaction and collaboration between learners and course organizers, enabling them to co-create course

content. Finally, the context for Study 3 is an online community, which is a company that develops and sells customer engagement platforms. In Study 3, the online community mediates interaction between end-users, professional developers and champions when discussing further development of an already existing software product. The online community provides a bundle of related tools that provide communication and feedback services for professional developers to interact with customers and other interested parties. This online community is a step beyond CRM because it engages a broad pool of end-users and lowers the threshold to making contributions by providing easy-to-use tools facilitating collaboration.

4.1.2 A qualitative approach (Studies 1 and 2)

A qualitative approach was chosen in Studies 1 and 2 because it enabled studying the phenomena of artifact co-creation in detail by scrutinizing emerging social practices between different participants when sharing ideas for how to develop a software product (Study 1) or learning resource (Study 2) further in the respective online communities. To distinguish between qualitative and quantitative research, a brief explanation of the two directions will be given, treating them as two opposing approaches.¹⁴ In qualitative research, the primary goal is to clarify the character or attributes of a phenomenon, whereas quantitative research attempts to establish the amount of the same phenomenon (Widerberg, 2001). Quantitative studies usually focus on larger samples of data and informants because they are concerned with counting “hard and fixed” data, for example, through surveys where the quality criteria is making objective and bias-free assumptions (Silverman, 2005). In contrast, qualitative studies focus on a small sample of informants to go into depth about a specific topic of interest, and they are more concerned with obtaining soft, flexible and subjective data (Silverman, 2005). In such studies, the goal is rarely to be objective but to understand the participants’ meanings and reasoning around a certain topic (Silverman, 2006). The qualitative approach in Studies 1 and 2 aims to gain a deep understanding of the social interactions and collaborations between the participants in further development of a software product (Study 2) or learning resource (Study 3).

¹⁴ The theories underlining these two different research approaches have much in common, and it could be beneficial to think about how to unite them instead of treating them as two different paradigms (Bergman, 2008; Silverman, 2005; Denzin, 2008). However, due to the limitations of space, this dissertation treats them as opposing approaches in the initial overview.

4.1.3 A mixed methods approach (Study 3)

In Study 3, the context of the artifact co-creation process is mass collaboration, implying a large dataset. As a result, a pure qualitative approach was deemed insufficient, since it goes in detail on a given phenomenon. Study 3 required an approach that also could handle large datasets. Therefore, it was decided to integrate qualitative and quantitative perspectives in an integrative mixed methods approach. The aim was to both capture specific details of what was occurring in the artifact co-creation processes between different participants in the online community (from a qualitative perspective) and be capable of analyzing the whole online community by its network structure and large amounts of data in relation to this (quantitative perspective). As a result, a mixed methods approach was applied, integrating SNA and IA, which are a quantitative and a qualitative approach, respectively. Applying a mixed methods approach is not straightforward as it integrates two different research approaches, and therefore will be dedicated more space (than the qualitative approach) for explaining the rationale behind choosing it and how it was applied in Study 3. It should be noted that this does not undermine the qualitative approach; they are both considered important.

A mixed methods approach was carried out in Study 3 in line with the thematic topic of mass collaboration, which is posed as a central issue in sub-research question 3. SNA was found appropriate because it is a method for studying large datasets from a quantitative social science perspective and focuses on relational aspects of the social interactions in a network or community (Scott, 2000), which was found highly relevant to studying artifact co-creation in a large community. However, this perspective alone is not sufficient because it was also a focus to explore what the participants in this large community were talking and collaborating about, and for that reason the qualitative methods template analysis and IA were chosen to code and analyze the empirical data, specifically the content in the messages. In mixed methods research, elements of both qualitative and quantitative approaches are integrated (e.g., the use of qualitative and quantitative viewpoints, data collection, analysis and inference techniques) for the purpose of obtaining a breadth and depth of understanding and corroborating the results (Tashakkori & Teddlie, 2010). A mixed methods study is defined as follows:

A mixed methods study involves the collection or analysis of both quantitative and/or qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority, and involve the integration of the data at one or more stages in the process of research (Creswell, Clark, Gutman & Hanson, 2003, p. 165).

In mixed methods research the most appropriate methods in qualitative, quantitative and mixed strategies to investigate a phenomenon of interest are selected and then synergistically integrated (Tashakkori & Teddlie, 2010). In Study 3, methods deriving from a quantitative perspective (i.e., SNA) and a method from a qualitative perspective (IA) were integrated and mixed. It should be noted that different researchers apply different frameworks of mixed methods designs, which are partly overlapping and partly incompatible. For example, Tashakkori and Teddlie (2010) used one typology of mixed methods design, whereas Creswell et al. (2003) used another. The mixed methods design typology provided by Creswell et al. was chosen for identifying a mixed methods research design because it was found to be close to the approach used in this dissertation, as elaborated below. Creswell et al. describe a mixed methods design that is divided into two directions: (a) a concurrent/parallel approach where the purpose of the design is to merge (or bring together) the qualitative or quantitative data in a parallel or in a concurrent way, and (b) a sequential approach in which one type of data (quantitative or qualitative) builds on or extends the other type of data (qualitative or quantitative). According to Creswell et al. (2003), this division provides for six different mixed methods design types: sequential explanatory, sequential exploratory, sequential transformative, concurrent triangulation, concurrent nested or concurrent transformative. In Study 3, a concurrent nested design is applied, bringing the qualitative and quantitative data together (Figure 1).



Figure 1: A concurrent nested design (Creswell et al., 2003)

A concurrent nested design is identified by its use of one data collection phase during which both quantitative and qualitative data are collected, thus allowing for the identification of different groups or levels of data within a design (Creswell et al., 2003). This embedded design reflects how a method addresses a question that differs from that addressed by the other method that is referred to as dominant; alternatively, the embedded method seeks

information from different levels (Creswell et al., 2003). The model shown to the right in Figure 1 was chosen, which is interpreted as taking a quantitative perspective as a starting point and then collecting qualitative data from the same dataset. The reason for choosing a concurrent nested design is that it helps put focus on two different levels of the empirical data existing within the same dataset: 1) SNA provides a (macro) overview of the data and 2) IA gives a detailed (micro) perspective on the same data. A similar approach is known as combined methods, characterized by sequentially combining the empirical data (Bazeley, 2017). However, the methods were not just sequenced in Study 3, but rather integrated both during collecting, analyzing and presenting the empirical data. Study 3 took the quantitative perspective as starting point when using SNA for analyzing the whole empirical dataset in the online community, and using SNA measurements as a zoom for what data to further analyze in detail from a qualitative perspective, employing IA. See section 4.4. for a detailed explanation of how SNA and IA as methods were used for analyzing the empirical data in Study 3. This specific integration of SNA and IA is in line with a concurrent nested design. SNA allowed for an overview of the large set of quantitative data, and IA allowed me to add in-depth interactional qualitative data from an SNA-informed selection of discussion threads, which was useful in providing different levels of data. The concurrent nested design is useful because it serves a variety of purposes, such as providing the researcher with a broad perspective through its use of different methods instead of one predominant method (Creswell et al., 2003). An important aspect of mixing these methods is the value of integrating them while collecting, analyzing and presenting the data in Study 3. The model shown in Figure 1 does not indicate the ways in which the two types of empirical data were integrated during the analysis of the findings. For that purpose, a different mixed methods strategy was employed underlining another central issue in applying a mixed methods approach which is to clarify the integration of the data during the analysis.

research that involves multiple sources and types of data and/or multiple approaches to analysis of those data, in which integration of data and analysis occurs *prior* to drawing final conclusions about the topic of investigation. A study in which integration occurs only as conclusions are being drawn from separate sub studies would better be described as multimethod than mixed method (Bazeley, 2017 p.7).

Tashakkori and Teddlie (2010) distinguish between integration occurring at only one stage of the process versus it occurring throughout the study and therefore propose a distinction between quasi-mixed and mixed designs. When integrating data in the analysis in Study 3, it

reflected a mixed design with regards to mixing the data sources, implying that both types of data (qualitative and quantitative) were available for the selected individuals and were linked during the analysis and interpretation of results. See Table 1 for an example of how the empirical data in Study 3 were organized in a table with the purpose of mixing, interpreting and presenting the empirical data during analysis. The purpose of presenting the table in this section is to illustrate and elaborate on the format of how the empirical data were organized and mixed according to both qualitative and quantitative elements on an overarching level in Article 3. The table is used as a structure for analyzing all the empirical extracts in Article 3 and is therefore not presented with its content here, since this is presented in Article 3.

Table 1: Integrating data during analysis (adapted from Jordan and Henderson (1995))

<i>Turn</i>	<i>Participant</i>	<i>Text from discussion thread</i>	<i>NrmDegree</i>	<i>NrmBetweenness</i>
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This table was inspired by Jordan and Henderson`s (1995) Interaction Analysis table, extending it with two columns containing SNA measurements, thus combining two sets of data in the analysis. In Table 1, the qualitative data are displayed in the columns headed “Participants,” “Turn” and “Text from Discussion Thread.” The quantitative data gathered from the same participants are displayed in the columns headed “NrmDegree” and “NrmBetweenness.” SNA is a tool for understanding the social interactions in the relationships between participants in networks, and it is used for understanding the network in the online community in Study 3. “NrmDegree” and “NrmBetweenness” are centrality measures deriving from SNA representing the quantitative data. Centrality measures in SNA are algorithms that use graph theory to calculate the importance of participants (nodes) in the network. These centrality measures are used for analyzing the network in the online community in Study 3 for getting network information about the online community deriving from calculating the large amount of data in total. “NrmDegree” is one SNA centrality measure used for getting information about which discussion threads are the most active in the online community and who are the most active participants in the discussion threads (Hannemann & Riddle, 2005). “NrmBetweenness” is another SNA centrality measure used for analyzing who are the most powerful or influential participants in the online community. A powerful or influential participant in SNA according to betweenness centrality is defined as the number of participants dependent on this specific person for coming into contact with other participants in the network (Hannemann & Riddle, 2005).

Table 1 is an example of how both qualitative and quantitative data were integrated and mixed during analysis and presentation of data in Article 3. This has similarities to an integrative mixed methods research which focuses on the type of integration where the goal is to create purposeful interdependence between the methods and their associated analyses (Bazeley, 2017). In integrative mixed methods research, different directions exist, with a hybrid strategy being one. The integration of IA and SNA, in Study 3, is in line with the use of integrative mixed methods research and the branch of hybrid strategies since it incorporates empirical data from different data sources both during interpretations and conclusion. Hybrid strategies inherently combine both qualitative and quantitative elements to create a single source or dataset that is then further examined using iterative quantitative and qualitative strategies (Bazeley, 2017).

SNA is employed for analyzing the social structures (by centrality measures such as degree and betweenness centrality) in the online community, providing a representation of the relational structures found in the discussion threads as defined by the activity connected with participants' interactions. IA is used for analyzing in detail the content in the discussion threads and what the participants are discussing. Using SNA for analyzing the social structures in the online community in Study 3 according to centrality measures provided important information about the whole network of participants, which was not possible to acquire by relying solely on IA. See section 4.4.2 for more detailed arguments for why IA was chosen as a relevant method according to the research questions. This integration of methods enabled both analyzing all the selected data in the whole community and understanding what was occurring in this community at a more detailed (interactional) level. Using different methods and integrating them also further justifies the choices of data selection. For example, in Study 3, SNA and IA are integrated and supplement each other, enabling viewing the same segment of data from different angles. Fugelli, Lahn and Mørch (2013) also value the approach of combining qualitative and quantitative data. They combine SNA and content analysis to analyze meaning-making processes in mail exchanges between different participants in a web server open source development project. In Article 3 in this dissertation, and Fugelli et al. (2013), a combination of qualitative and quantitative methods was found to provide a more comprehensive approach to data collection and analysis. However, Study 3 differs from their study because it has a more detailed focus on how the social interactions represented by the utterances in the discussion forum build on each other and in total create a shared software product that none of them could have created alone.

A limitation with employing a mixed methods design is that the researcher must handle multiple methods and be able to know how to use each method and integrate the methods. Another drawback with integrating several methods is that it is demanding and time consuming for the researcher. First, it takes time to learn and understand the theoretical assumptions embedded in the methods. Second, it takes a lot of time and effort to use the technological tools connected to the methods to be able to perform the analysis. For example, in Study 3, several technological tools were used when analyzing the empirical data, as explained in section 4.4. As a result, the time dedicated to analysis using the different methods had to be split, instead of dedicated all available time to one method. One of the main disadvantages of a mixed methods design is the danger of the research losing flexibility and depth, which often is postulated as the main advantages with qualitative research (Driscoll et al., 2007). Also, SNA and IA derive from different research traditions (quantitative and qualitative approaches), and they therefore have different starting points in understanding, for example, how knowledge is defined and created. As a result, there is a challenge in combining these two research traditions; however, this dissertation integrates them anyway due to the richness it provides to the empirical data. There is a debate in the mixed methods literature regarding the demarcation of qualitative and quantitative methods because they may stem from different research traditions and therefore may be difficult to mix. One issue in the debate is the selection of samples in a concurrent nested design and whether it is preferable to have the same individuals participate in both samples to increase the compatibility of the data and the results (Creswell et al., 2003, referring after Bergman, 2008). The two types of data were collected and sampled from the same individuals in the online community in Study 3, then analyzed from different views (macro and micro). In the macro view on the data, all individuals were present, whereas in the micro view, only a subset was present. Combining the quantitative and qualitative data yielded a rich picture of the reality of the study reported because the different data sources strengthened and enriched each other.

4.2 Overview of studies and methods

This section provides an overview of the studies and the methods employed in this dissertation.

4.2.1 Overview of the three studies

Three studies provide the empirical data serving as a background for this dissertation. The different studies are explored in separate studies, reported on in the articles. Table 2 is

intended to show the coherence of the dissertation across the studies with regards to title, research questions, empirical data, theoretical concepts and findings.¹⁵ The different case studies in this dissertation examine the phenomena of artifact co-creation in detail, however, from slightly different angles. Study 1 defined mutual development in small group collaboration context, whereas Study 2 explored the phenomena of mutual development in an informal educational context, and Study 3 investigated mutual development in a mass collaboration context (see Table 2 for an overview and more details on the case studies). This points to how the studies build on each other, as well as their coherence in research topic and connections to the general theme of this dissertation. The organization of the table aims to show how the notion of mutual development evolves from its inception in Study 1 to exploring the concept in an informal educational context in Study 2 and in a mass collaboration context in Study 3. The notion of “shared concepts” used in Table 2 refers to the theoretical concepts that are used across the studies,¹⁶ which are co-configuration, user-driven innovation, mutual development, meta-design and modding. These theoretical concepts are described in Chapter 3 and comprise the fundamentals for analyzing mutual development. In addition, some specific concepts are used in the two last studies. The specific concept used in Study 2 is Zone of Proximal Development (ZPD), and the specific concepts used in Study 3 are mass collaboration (described in Chapter 2), degree centrality, betweenness centrality (these concepts derive from SNA and are described in Chapter 4), collaborative tailoring and collaborative knowledge creation (described in Chapter 3).

¹⁵ Table 2 is inspired from Søreide (2007) and Hetland (2017).

¹⁶ The divide between shared and specific concepts is inspired from Hetland (2017).

Table 2: Overview of the studies

	Article 1 (Study 1)	Article 2 (Study 2)	Article 3 (Study 3)
<i>Title of Article</i>	Mutual Development: A Case Study in Customer-Initiated Software Product Development	Participatory Pedagogy in an Open Educational Course: Challenges and Opportunities	Mutual Development in Mass Collaboration: Identifying Interaction Patterns in Customer-Initiated Software Product Development
<i>Research question(s)</i>	How there is mutual development between customers and professional developers mediated by ICT support systems?	1. What processes of interaction occur in an online open educational course? 2. What challenges and opportunities emerge?	What are the patterns of interaction between end-users and professional developers in a mass collaboration community, as seen from a mutual development perspective?
<i>Empirical data</i>	10 ½ hours of video material from interviews with 11 participants	Data collected from May to October 2011, primarily. In this time period, 32 tasks were created and 160 messages were posted.	Data collected during a six-month period from March 2012 to August 2012. The selected population consisted of 41 topics (discussion threads), 229 actors, 31 higher-order codes and 546 statements.
<i>Theoretical concepts</i>	Shared concepts: co-configuration, modding, meta-design, user driven innovation	Shared concepts: mutual development, co-configuration, meta-design, user-driven innovation. Specific concept: Zone of Proximal Development (ZPD)	Shared concepts: user-driven innovation, mutual development, meta-design Specific concept: mass collaboration, degree centrality, betweenness centrality, collaborative tailoring, collaborative knowledge creation
<i>Findings</i>	Identifying mutual development between end-users and professional developers in small group collaboration in terms of five sub-processes: Adaptation, Generalization, Improvement request, Specialization and Tailoring.	Identifying mutual development processes in an informal educational context. Two different processes of interaction between learners and course organizers: Problem identification and Co-creation of tasks.	Identifying mutual development in a mass collaboration context. In terms of four patterns of mutual development in mass collaboration: Gatekeeping, Bridge-building, General development and User-user collaboration.

Table 3 below provides an overview of the number of participants and selected discussion threads that were chosen to be part of the data material in the different studies. The sampling frame is a list of elements that comprise the study population (Babbie, 2014) and presents the total population of empirical data included for analysis in the respective studies. Topics refer to the number of different discussion threads. Table 3 shows a gradual increase in

the number of participants, which reflects a change in research focus from small group collaboration to mass collaboration.

Table 3: Number of participants in the three Studies

	Study 1	Study 2	Study 3
<i>Total number of participants (and activities)</i>	35 participants	380 learners 763 followers 46 course organizers 32 discussion threads	269,280 participants 47 champions 50 employees 19,747 discussion threads
<i>Number of participants selected for analysis</i>	11 participants	60 participants 20 discussion threads ¹⁷	229 participants 41 discussion threads ¹⁸

4.2.2 Selection criteria for the case studies and participants

In this section, the rationale for choosing the different studies and the ways in which they are connected to my research interests is addressed. Then the selection criteria for choosing the case studies and participants within the studies are described.

Study 1 was chosen due to its focus on being a company that had focused on including customers in their software product development processes, which aligned with my research interests. Study 2's focus on a cMOOC, was selected because it is an interesting phenomenon in an online community that enables end-users to take active roles in further development of a learning resource. Study 2 was relevant to select in connection to Study 1, as it made it possible to look at processes of end-users' activities in a different context than in Study 1. Study 3 was selected because of also being an online community emphasizing the active inclusion and participation by end-users in software product development processes, but in a purely online context where a large number of people, a mass, were interacting. The coherence in choosing these studies is that they all emphasize the relationship between end-users, professional developers and champions in further development of a software product (Studies 1 and 3) or between learners and course organizers in further development of a learning resource (Study 2), and all the studies underline the focus on including end-users as active and contributing participants.

¹⁷ The discussion threads in Study 2 reflect the different co-created tasks between learners and course organizers.

¹⁸ The discussion threads in Study 3 consist of the different suggestions for how to improve the software product further. This is also referred to as topics in Article 3.

In Study 1, the criteria for selecting the participants to be interviewed were as follows: a) Participants with the longest employment records were selected; b) two key customers were selected because they had been using the company's products for the longest time and were advanced users with a lot of knowledge of the product. The criteria for selecting the JavaScript cMOOC as the focus of study in Study 2 were: (a) its perceived popularity and (b) its large number of course organizers and participants. In Studies 2 and 3, in the online community in which the discussion threads were selected, the selection of participants was given as they are an integrated part of the data in the discussion threads. This is because when a participant posts a contribution in the online community the contribution is always tagged with the profile name of the participant. In Study 3, the selection of discussion threads was done in several steps. First, the discussion threads were extracted from the online customer community. The focus was on the customer community and not the developer community because of the study's interest in the interactions among end-users, champions and professional developers. It was also decided to go back in date and select discussion threads that were six months old and still ongoing, and from there on chronologically selecting 41 discussion threads. The reason for going six months back in time to collect the discussion threads was to capture the historical record of the context of the interactions that were still active when the data collection started. In the online community in Study 3, all participants who want to create a discussion thread must tag their contributions so that it can be organized into one of the four sub-categories: "share an idea," "give praise," "ask a question" and "report a problem." Study 3 only selected empirical data from the two sub-categories most relevant to the research focus: "share an idea" and "give praise." The sub-categories "ask a question" and "report a problem" were excluded because they were beyond the scope of the research questions and in order to select a subset that was both relevant and representative of my research interests. Each sub-category also contained additional predefined top-level categories, such as: "planned idea," "not planned idea," "under consideration" and "implemented idea." Study 3 emphasized "completed ideas" because it was most relevant to the research questions. This category includes the entire process from idea generation to the implementation of a feature. Hence, the findings could provide information about all the phases of "share an idea." These categories were chosen because they best enabled the study to follow a development process (of an already existing product) in which both end-users and professional developers were involved.

Template analysis was used as a selection criterion for choosing the empirical data in

Study 2. One important part of designing Study 2 was ensuring that all discussion threads representing a co-created task were included in the selected empirical material. As a result, all 20 discussion threads involving the co-creation of a task were selected for further analysis using template analysis. The discussion threads that were not chosen for further analysis were more concerned with formalities and the organization of the course. Study 2 analyzes fewer discussion threads than Study 3, but the dataset encompasses all the data that was available and relevant to the study. Given the relatively large number of participants in Study 2, consisting of 1189 participants enrolled in the cMOOC, the methods applied to analyze the empirical data should be reflected upon. SNA was not applied in Study 2 because at the time, template analysis was considered sufficient. However, in hindsight, SNA might have been a relevant method to include in the analysis of the empirical data for the same reasons SNA was used in Study 3: It could have provided network information on this cMOOC and analyzed who were talking to who, who were most active in which discussion threads, which participants are were most influential, etc. This is an area for further research.

4.2.3 Overview of methods used during data collection, screening and analysis

This section elaborates and justifies the methods used in collecting, screening and analyzing the empirical data and explains how they are integrated. The details of implementing the specific methods are explored in section 4.3. and 4.4. When working with empirical data in this dissertation, a three-step approach was used (see Figure 2 below): 1) data collection, 2) data screening and 3) data analysis.



Figure 2: Three-step approach when working with empirical data in the studies

Data collection refers to the different methods used when collecting the empirical data in the studies (interviews, focus groups and virtual ethnography). Data screening refers to the process of screening and coding the whole empirical dataset in the respective studies as an intermediary analysis, using template analysis, to justify which data extracts to select for further examination. Finally, during data analysis, selected parts of the empirical dataset were analyzed in detail, using template analysis (Studies 1 and 2) or SNA and IA as a mixed

methods approach (Study 3). Figure 2 illustrates the different phases of working with empirical data in the studies. It should be underlined that analyzing and screening data is a continuous process that occurs in iterations (repeating the process described above). Therefore, data collection, screening and analysis do not follow a strict linear process with stages that must be completed before the next starts. Even so, in retrospect, one might look back and describe the analytical work in terms of steps. Table 4 shows an overview of the different methods used in the studies when collecting, screening and analyzing empirical data.

Table 4: Overview of methods used during data collection, screening and analysis

	Study 1	Study 2	Study 3
<i>Methodological approach</i>	Qualitative	Qualitative	Mixed Methods
<i>Data collection</i>	Interviews and focus groups	Virtual ethnography	Virtual ethnography
<i>Data screening</i>	Template analysis	Template analysis	Template analysis, Social Network Analysis
<i>Data analysis</i>	Template analysis	Template analysis	Interaction Analysis, Social Network Analysis
<i>Nature of data</i>	Face-to-face interaction	Discussion threads in an online community	Discussion threads in an online community
<i>Number of selected participants</i>	11 participants	60 participants	229 participants
<i>Geographical distribution</i>	Local (Norwegian)	Global	Global

There are many different methods a researcher can use. It is essential to choose a method that aligns with the research questions and is best fitted to collecting, screening and analyzing data in order to answer the research questions. There are no right or wrong methods, only methods that are appropriate to your research topic and the model/methodology with which you are working; however, the choice of methods must be critically reflected upon (Silverman, 2005). The necessity to employ more than one method emerged because of the change in the number of participants from Study 1 (Article 1) to Study 2 (Article 2) and 3 (Article 3); see Table 4, which impacted the choice of methods. There was a stepwise evolvement of the methods applied in this dissertation, which was regulated by the context of the studies shifting from small group collaboration (Study 1) to mass collaboration (Studies 2 and 3). In the studies, there was an increase in the size of the empirical datasets, which unraveled a need to employ other methods to analyze the data. This resulted in choosing SNA as a method for analyzing large datasets (when integrated with qualitative methods). This is

further elaborated in section 4.4.1. Both Articles 2 and 3 use empirical data collected directly from online communities using virtual ethnography, whereas Article 1 uses interviews as the main technique for collecting data (see section 4.3.1). In retrospect, it could have been relevant to also go into the CRM online community in Study 1 to collect data directly from the community as a supplement to the interviews. However, this was not part of the research design. In summary, at first impression, the methods applied in the studies in this dissertation may appear complex. However, all the methods are connected and have specific purposes in the studies. The methods are connected because all three studies use template analysis for screening and selecting empirical data, using it as a scientific justification for selecting what empirical data to extract and take a closer look at in the next rounds of detailed IA. Getting access to the research field and collecting the empirical data in Study 1 was impacted by me being part of a large EU-funded research project which inhabited several researchers. As a result, I did not have any impact on deciding which company to study or what methods to use, as this was controlled by the project leader. However, I was an important part of creating the interview guide, planning the data collection and collecting the necessary empirical data in a joint data collection process. The limitations of this were that certain boundaries existed, such as within the research project, and the interview guide, there existed several purposes and research questions. Being part of a large research project gave thematic direction when deciding the unit of analysis, and as a result it was important to limit the research focus by creating research questions early in the process and ensure that the interview guide reflected my research interests as well. In Study 2, I collaborated with a research partner who provided access to the case study and the empirical data. However, I made a substantial contribution to preparing for the data collection and collecting the necessary empirical data in a joint data collection process. I also contributed to coding and analyzing the empirical data. For more detailed explanations of what I contributed within the articles, see Appendix 2. In Study 3, I chose the case study and had access to the empirical data. I also did the majority of work in preparing for the data collection and collecting and analyzing the empirical data. In total, this points to an evolution across the studies by which I gradually gained more responsibility and control over choice of methods, case and analysis of the data.

4.3 Methods used during data collection and screening

In this section, the methods used during data collection and screening are elaborated.

4.3.1 Interviews and focus groups

Interviews and focus groups were the data collection techniques used in Study 1 because of the nature of the study, being a small-scale case study. Silverman (2005) emphasizes that open ended interviews are often used with a small sample or population. In Study 1, key participants, meaning customers who had been working with the product for a long time, were selected and interviewed. The first data collection occurred at the Oslo office interviewing two participants. The main data collection involved interviews performed at the office in Stavanger over three days. In a later stage, a focus group interview was arranged to summarize the data gathered in the Oslo and Stavanger offices. Attending this focus group interview were two participants from the Oslo office and one from the Stavanger office. The purpose of this meeting was to interview the participants from both offices at the same time. In a focus group, the researcher is flexible and stands back from the discussion so that group dynamics can emerge (Silverman, 2006). The focus group was chosen to suit the purpose of an exploratory case study to let the conversation evolve according to a semiformal interview guide. In addition, two open-ended interviews were conducted with two of the company's most prominent key customers, due to their prolonged experience with the product. Open-ended interviews are useful for obtaining rich data through the active listening of the interviewer (Silverman, 2006). However, one should be aware that when using interviews and focus groups, one cannot interpret the participants' answers as true or false reports on reality, but rather as displays of perspectives (Silverman, 2006). To overcome this potential limitation, when conducting the interviews and focus groups, there were always at least two researchers present to capture as much of the situation as possible (these situations were also video recorded), with one researcher writing field notes and the other leading the interview process. Finally, the empirical data were discussed in collaboration with colleagues at research meetings.

4.3.2 Virtual ethnography

Using aspects from virtual ethnography to study social interactions in online communities arose with the coming of the internet, when it became clear that interesting social formations were beginning to emerge from people communicating and organizing themselves via email, web sites, mobile phones and the rest of the increasingly commonplace mediated forms of communications (Hine, 2005). Different terms are used to describe methods of conducting online research, including virtual ethnography (Hine, 2005, 2008), netnography (Kozinets, 2010) and ethnography for investigating the internet (Hetland & Mørch, 2016). Virtual

ethnography was chosen as a plausible method to study the interactions and collaborations between learners and course organizers in Study 2, and between end-users, champions and professional developers in Study 3, because the phenomena of interest occurred in purely online contexts and were publicly available (i.e. a shared social phenomena). In Articles 2 and 3, there was not enough space to describe in depth how virtual ethnography was used to collect the empirical data, so this will be explained here. There are different techniques of carrying out virtual ethnography, ranging from “fly on the wall” (non-participant observation) (Hine, 2008) to engaging in the interactions and in between participant observer. It depends on the context of the virtual environment and to what extent the researcher is actively immersed in the empirical data. In Studies 2 and 3, the online communities resemble discussion threads because they consist of textual replies and comments made by participants. When participating in the online community in Study 3, a textual message was written in the discussion threads from which it was intended to collect empirical data. Before doing this, I was careful to register my name as “RenateAndersenResearcher” and made it a point to make myself visible in the community to increase the awareness of my presence as a researcher to strive for good research ethics and make sure the participants knew that I was collecting data based on their activities (see more about this in section 4.5.4). Methods used for data collection in virtual ethnography include online surveys and interviews, recording of message content, web scraping, etc. (Kozinets, 2010). The interactions and collaborations in the online communities were studied during a period of 6 months (Studies 2 and 3) where empirical data were collected from the online communities (see section 4.2.2 for more details on the selection criteria for the discussion threads). Access to the communities was gained without login and password credentials in Studies 2 and 3 because the sites were open to the public and information was available to everyone. The ethical dilemmas concerning collecting publicly available online data are further discussed in section 4.5.4, as care must be taken not to infringe on individual privacy rights.

4.3.3 Template analysis as an intermediate step

This section elaborates on how template analysis was used as a method and an intermediate step when screening and analyzing the empirical data in the studies. Template analysis was used as a scientific method for selecting the empirical data to extract from the whole dataset and focus on through screening and coding the whole empirical dataset. This method was chosen because it provides a scientific justification for selecting what empirical data to extract from the dataset. Template analysis was applied in all the studies, which is a common

denominator in the methods in the dissertation, since it focuses on creating templates deriving directly from the empirical raw data. This aligns with this dissertation's aim of studying the phenomena of artifact co-creation in detail and staying as close to the participants' statements as possible. This is also in line with a qualitative approach emphasizing understanding participants' experiences of a given phenomenon. This means that neither a top-down nor a bottom-up analysis of the data was performed, but, rather something in between when the intermediate terms were created as "templates." A top-down approach refers to using theoretical concepts first to analyze the data, whereas a bottom up approach refers to not using theoretical concepts but analyzing the raw data and letting the empirical templates emerge. In this dissertation, the templates were derived from the empirical raw data, but the selected data were also analyzed in the next step using the theoretical concepts explained in the conceptual framework in Chapter 3. Template analysis enables the researcher to produce a set of codes (i.e., a "template") that represent the themes identified in the textual data (King, 1994). A strict bottom-up analysis was not employed when screening the data. Instead, a combination of data-driven and theory-driven processes was used, and the intermediate terms were chosen to be templates. In the empirical data in Study 1, five terms were identified as representing the different processes of mutual development (Adaptation, Generalization, Improvement Request, Specialization and Tailoring), which served as templates when I screened all the data material. King (1994) distinguished three features of template analysis: *defining codes*, *hierarchical coding* and *parallel coding*. The way in which this process was further conducted is explained thoroughly in Article 1. Examples of codes that emerged in screening the empirical data in Article 2 are "Problems with creating tasks" and "Co-creation of task" Going over the data in Article 2 yet again, with the research questions in mind, empirical data supporting the processes of "Co-creation of task" and "Problems with creating tasks" were found. To establish the concept of mutual development as a theoretical notion, aspects from the constant comparative methods (Glaser, 1965) is drawn on. The constant comparative method is used to develop a theory using a bottom-up approach to analyzing data. Glaser (1965) emphasized that the constant comparative method could be used to generate theory in four stages: 1) comparing incidents applicable to each category, 2) integrating categories and their properties, 3) delimiting the theory, 4) writing the theory. The constant comparative method (Glaser & Strauss, 1968) bears resemblance to template analysis (King, 1994) because it emphasizes the importance of conducting the analysis in conjunction with empirical data, i.e. developing a theory using a bottom-up approach, but it has a more explicit

focus on developing a theoretical notion deriving from empirical data in a bottom-up analysis.

When conducting template analysis in Studies 2 and 3, each discussion thread was first categorized, and the data were roughly divided into different thematic segments. Then, after going over the empirical data in several rounds, representative discussion threads relevant to the research questions were selected, with at least 2-3 discussion threads connected to each template code. Next, when a discussion thread was justified as relevant after several rounds of template analysis, all of the data in the selected discussion threads were analyzed. Early on in the data collection process, due to the large amount of data, it was chosen to mainly focus on the text-based contributions and participants included in the discussion threads. The selection of participants is therefore closely connected to the discussion threads in Studies 2 and 3. When selecting which discussion threads to focus on, in the next round, all the participants that had been part of the discussion thread were included. This means that if a participant in a discussion thread had at least one posting, it was included in the empirical dataset. So, deviating empirical data could have included empirical extracts or utterances that did not contain any artifact co-creation processes and consisted of, for example, mainly “yes or no” answers, but this was not the case in the majority of the dataset. The majority of the empirical data in Studies 1, 2 and 3 consisted of active end-users who made mostly meaningful postings that added to the artifact co-creation processes. Nevertheless, looking closer at the empirical data in Article 3, utterances within the discussion threads that do not support or align with an artifact co-creation process exist. One example can be seen in Excerpt 1, utterance 7, in Article 3: where it is stated “My pleasure!” This can be seen as one example of deviant empirical data where the participant only contributes with a short answer and do not contribute to the artifact co-creation process. However, this data is also included in the dataset, since all postings by all participants in the selected segment of the discussion threads are included in the SNA analysis, and the subsequent IA analysis. When selecting empirical excerpts it was a concern to choose entire segments of text and not split the utterances up in order to present the data as naturalistic and verbatim as presented in the online community. As a result, utterances that not directly supports artifact co-creation processes were included, which are examples of deviant data. This instance of deviant data may bias the SNA results in that the degree centrality of this end user is affected by the total amount of entries, regardless whether this is a short contribution or part of an artifact co-creation process. A possible limitation is therefore that an end user having a high degree centrality according to SNA measures indicates an active end user, but in reality only provided short answers (“My

pleasure!”) and as a result not really is a central person, even though the person has a high degree centrality. This risk was counteracted in Article 3 by also using qualitative methods for correlating and reassuring that the SNA measurements and the qualitative contents of the utterances are compatible. Only two such utterances of deviant data were identified in the extracts in Article 3, however, in a large dataset one can assume that several instances like this are apparent.

4.4 Methods used to analyze data

This section presents the methods used in the three studies to analyze the data: SNA and IA.

4.4.1 Social Network Analysis (SNA)

SNA was used for analyzing the empirical data in the online community in Study 3. SNA is a method for analyzing social structures in networks using graph theory to calculate different algorithms to examine the social relations in the data. As a quantitative approach to studying large online communities, SNA provides a set of methods for analyzing the relational aspects of social structures (Scott, 2000). These relational data can be collected, stored and prepared for SNA by applying various algorithms and techniques (Borgatti, Everett & Johnson 2013; Freeman, 1979; Hanneman & Riddle, 2005). When collecting, storing and preparing for an SNA analysis, several choices must be made, which are elaborated in this section. SNA was used in a four-step manner in Study 3 (Figure 3).¹⁹

¹⁹ The model was inspired by Bergsund (2017), but adapted to the context of this dissertation.

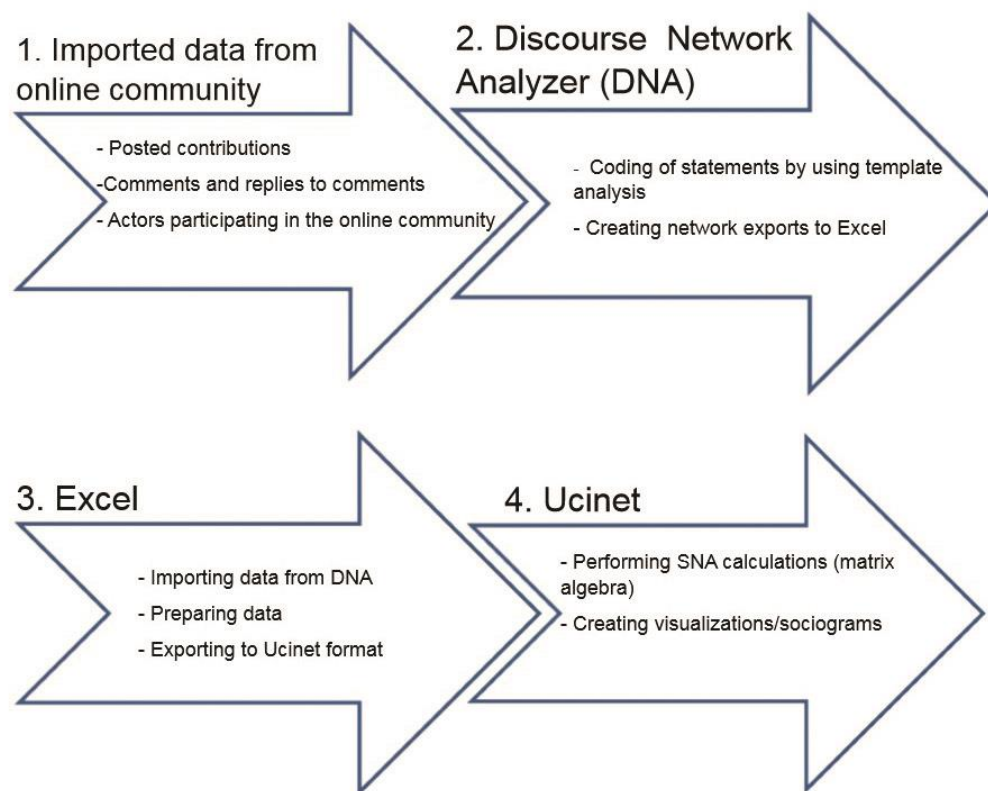


Figure 3: Overview of the four-step process of performing Social Network Analysis (SNA)

First, the empirical data, consisting of all the posted contributions, comments and answers to comments, were collected from the online community. Second, the data was manually implemented, including all the text messages from the different discussion threads, into a tool called the Discourse Network Analyzer (DNA) (Leifeld, 2010). DNA is a qualitative content analysis tool with network export capabilities. The researcher can import text segments and code statements that participants make, and the program will return matrices of actors connected by shared concepts (Leifeld, 2018). DNA is a tool that takes qualitative empirical data and converts it into a file format that can be imported to Ucinet, which is a software tool for conducting SNA analysis (Borgatti et al., 2002). I chose to use DNA because both qualitative data are stored and analyzed and quantitative data are created and analyzed as well. These data were used as a starting point for doing SNA measurements in the tool Ucinet, which was chosen because it is a well-established tool for doing SNA analysis. The 41 selected discussion threads that were implemented into the DNA resulted in the manual coding of 541 statements. Next, the data were exported, by using the “network export” function in DNA, and next several different “network exports” were created, which provided

the foundations for performing the SNA analysis in Ucinet (Borgatti et al., 2002). Figure 4 shows a screenshot of the DNA tool.

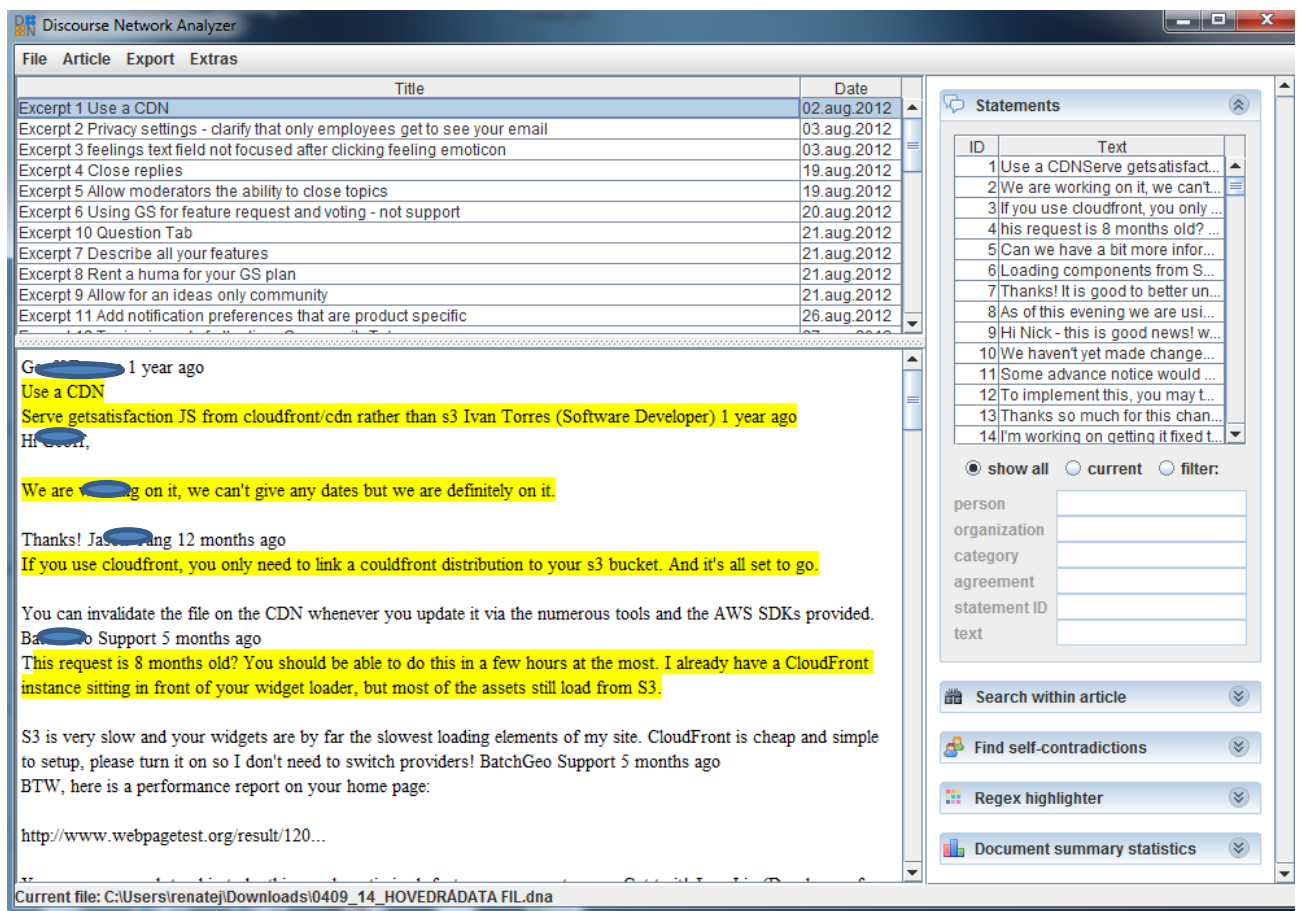


Figure 4: Screenshot of the Discourse Network Analyzer (DNA) used in the second phase of the data analysis

A network export defined as the “affiliation network,” which is explained below, was required to collect data from both the actors and discussion threads, which resulted in an Excel file containing a two-mode matrix (dual mode; affiliation). Third, the exported data were imported to Excel where they were prepared for analysis and exported to a format that was accepted by Ucinet. Finally, the empirical data were imported to Ucinet for performing centrality measurements and visualizing them as sociograms. In study 3, not all available SNA centrality measurements were employed, but two central SNA measurements that were viewed as relevant to the research questions were chosen. Degree and betweenness centrality as SNA measurements were chosen because they were found to be the most relevant to the focus of the research with regards to getting an overview of the most active discussion threads and participants and who has the most power in the online community. The degree and betweenness centrality values for the 20 most active participants and discussion threads in the

network were calculated in Ucinet. When conducting SNA analysis, two different networks can be taken as starting points for analysis: a) single-mode network data (i.e., one dataset) or b) two-mode (dual mode; affiliation) network data²⁰ (i.e., two different datasets) (Borgatti et al., 2013). A single-mode network consists only of actors (e.g., a chat group), whereas a two-mode network consists of two non-overlapping sets of nodes (e.g. an online community consisting of actor nodes and affiliation nodes) (Breiger, 1974). In a single-mode network, there is a link between nodes when there is a direct communication between the actors. In affiliation networks, communication is mediated by a common information space or affiliation, such as an online community. A connection between the actors in the online community is created among the actors according to their contributions in the community, which is called indirect communication. In Study 3, the empirical data represent a two-mode network consisting of participants and their contributions to different discussion threads. A link is created between the nodes (participants) and a discussion thread if the participants have contributed with a textual reply to the thread. For coding purposes in DNA, a link is created between a participant and a discussion thread when it is registered in the system that, for example, an end-user contributed with a textual reply to a specific discussion thread. The effect is that the system “ticks off” or registers this reply as an entry (0, 1, 2, 3, 4, etc.), such as entry “one.” Because Ucinet requires one-mode data to perform SNA measurements, the two-mode data coded in DNA were converted to a one-mode network in Ucinet to perform the SNA analysis correctly (see Figure 5), that is, to compute two-mode degree centrality and two-mode betweenness centrality. As a result, in Study 3, an affiliation network based on a converted two-mode matrix was created to represent the interaction between participants mediated by different discussion threads. For a screenshot from Ucinet as used in the fourth phase (see Figure 3 above) of the data analysis process, see Figure 5 below, showing the converted two-mode dataset (participants versus participants) displaying the raw data file (deriving from DNA and Excel). Due to the large amount of data, the screenshot only shows a small part of the entire raw data file, but it gives an impression of the structure of the data and the tool. The data shown in the screenshot was the starting point for creating Figure 3 in Article 3.

²⁰ This is also often referred to as a dual-mode network (Breiger, 1974).

The screenshot shows the UCInet software interface with a matrix of interaction counts. The matrix is organized into two main groups: 'Champion' (participants 9-18) and 'Developer' (participants 1-8). The diagonal elements represent self-interactions, and the off-diagonal elements represent interactions between different participants. The matrix is symmetric, indicating that interactions are mutual.

	Champion_9	Champion_1	Champion_10	Champion_2	Champion_3	Champion_4	Champion_5	Champion_6	Champion_7	Champion_8	Developer_1	Developer_10	Developer_11	Developer_12	Developer_13	Developer_14	Developer_15	Developer_16	Developer_17	Developer_18	Developer_2	
Champion_9	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Champion_1	0	5	0	2	0	0	4	0	6	2	0	0	2	0	0	0	0	0	0	0	0	4
Champion_10	0	0	4	2	6	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
Champion_2	0	2	2	31	7	0	2	0	6	0	0	0	6	0	6	0	0	0	0	0	6	2
Champion_3	0	0	6	7	39	4	0	0	4	0	0	0	8	0	12	4	0	0	0	0	0	11
Champion_4	0	0	0	0	4	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	2
Champion_5	0	4	0	2	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4
Champion_6	9	0	0	0	0	0	0	9	0	0	0	0	0	0	6	0	0	0	0	0	0	0
Champion_7	0	6	0	6	4	0	4	0	13	4	0	0	8	0	0	0	0	0	0	0	0	4
Champion_8	0	2	0	0	0	0	0	0	4	4	0	0	4	0	0	0	0	0	0	0	0	0
Developer_1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Developer_10	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Developer_11	0	2	0	6	8	0	0	0	8	4	0	0	26	0	4	0	0	0	0	0	0	6
Developer_12	4	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Developer_13	6	0	4	6	12	0	0	6	0	0	0	0	4	0	34	0	0	0	0	0	0	6
Developer_14	0	0	0	0	4	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	2
Developer_15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Developer_16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Developer_17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0
Developer_18	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
Developer_2	0	4	0	2	11	2	4	0	4	0	1	0	6	0	6	2	0	0	0	0	0	37

Figure 5: A screenshot from Ucinet as used in the fourth phase of the data analysis process (see Figure 3), showing the converted two mode dataset to one mode (participants versus participants)

A possible weakness of the affiliation network could be attributed to the assumption of a link between two participants based on their interactions within the same discussion thread despite the absence of direct evidence that they were in fact communicating with each other. This assumption is addressed and tested in the IA to balance and nuance the interpretation.

Through this, it was possible to read the content of the messages posted by end-users and determine with a certain degree of accuracy whether two participants who posted in the same thread were aware of each other’s posts. In contrast, if a one-mode data matrix was chosen, it would only be possible to present which actors are talking to whom, but that would not be meaningful in the context of a discussion forum, and the dimension of the discussion threads as a mediating computer artifact would have disappeared. Finally, to visualize and analyze the SNA calculations, an affiliation network was created in Netdraw visualization software, which is a program that is part of the Ucinet package, as shown in Figure 3 in Article 3. SNA is a useful method for analyzing social relations in networks with large datasets because it ensures that central nodes are not overlooked. However, SNA does not yield information about the content of the actors’ contributions. In the worst case, this limitation may lead to misguided interpretations regarding who is powerful in the network according to degree and betweenness centrality. Descending to another and more detailed level of analysis focusing on the content of the actors’ messages is one way to address this limitation. Hence, there is a

need to combine SNA with IA to obtain information about the content of the messages in the different discussion threads, thus complementing the network data information.

Using technological tools for analyzing empirical data can both strengthen the data and be a limitation. Above the advantages and usefulness of the different technologies used to analyze the empirical data are described. All the technological tools serve a specific purpose and were deemed central and important for the necessary analysis of the complex and multi-faceted phenomenon of artifact co-creation in Study 3. However, there are limitations as well. One limitation is that it is important to be critical with regards to whether the technological tool visualizes and analyzes the empirical data appropriately according to the input data and research aims. This means that a user of the tool can misuse the tool and use criteria for creating matrices or sociograms that are inappropriate in the specific case. Therefore, it is necessary to have a plan for how to check the quality of the data afterwards. In Study 3, it was a concern after calculating the centrality measures and getting visualizations and sociograms as output data, to check their correspondence with the original raw input data file.

4.4.2 Interaction Analysis (IA)

IA is an interdisciplinary approach used in empirical investigations of the interactions of humans with other humans and the artifacts in their environment. IA allows investigation of human activities such as talk, nonverbal communication and artifact mediation (Jordan & Henderson, 1995). It can help in identifying routine practices and problems and the resources for their resolution (Jordan & Henderson, 1995). The overall idea of IA was applied to investigate textual contributions from discussion threads where there was actual turn-taking going on, along the lines of Arnseth (2004). The focus is not on face-to-face interaction, which often is video recorded and analyzed in line with the IA approach (Derry et al., 2010; Jordan & Henderson, 1995), but on the content in the turn-taking interactions that occur in the online communities and their discussion threads with textual communication. In IA, video recording is usually used as a foundation when conducting the analysis. However, in Study 3, IA was based on the empirical material retrieved from the textual contributions in the online community collected using virtual ethnography (Hine, 2008). The focus is on turn-taking interactions and the development of understanding in the discussion threads, and the unit of analysis is the contributions made by each participant when posting replies in the discussion threads. Stahl (2013) used a variant of IA to analyze students' synchronous text chats in the online Virtual Math Team environment. However, this dissertation differs from Stahl's study because he focused on small group interaction, whereas the focus in Study 3 is on mass

collaboration. In Study 3, IA was used to analyze the empirical data in detail, with a focus on using it as a lens for zooming in on the SNA macro data. The utterances in the selected discussion threads (micro data) were scrutinized in terms of how they build on each other and are connected. The role of the mediating computer artifacts during interactions was also taken into consideration. IA is used to examine the temporal organization of moment-to-moment, real-time interactions and the temporal ordering of talk and nonverbal activity (Jordan & Henderson, 1995). It is an underlying assumption of IA that talk and physical activity are intertwined in the turn-taking system (Jordan & Henderson, 1995). In Study 3, the contributions by the participants' replies in the online communities are organized chronologically so that it is possible to follow the discussion as it unfolds.

Another strength that IA provided to the analysis that would not have been possible with, for example, template analysis, is that one can consider the structure of events and chronological time (Jordan & Henderson, 1995). The data in the discussion forums are organized hierarchically within the discussion threads, with the newest contributions on top and with a time stamp on each reply. As a result it was possible also to analyze the sequence of events (time aspect). Looking at the discussion threads as a whole, one can see that there is a structure to the organization of the discussion threads. For example, it was found that they often started with an end-user or champion suggesting an idea for how to improve the product further and ended with a professional developer stating that the suggested idea was considered and integrated into the general product as a new feature, thus revealing temporal aspects of mutual development. Turn-taking is a central aspect of IA, and it is used to analyze a portion of the data in Study 3. When analyzing the empirical data in Article 3, each utterance was numbered and interpreted in the context of the other utterances (Jordan & Henderson, 1995). In Study 3, IA is used on naturally occurring data deriving from a discussion forum in an online community. One of the central findings in Study 3 is how participants during mutual development of a software product in a mass collaboration context create something together that none of them could have accomplished alone. One example of this can be seen in Excerpt 3 in Article 3. Ideas for how to develop the product further builds on prior messages and replies from the participants in the community. If the collective nature of mutual development were taken out, the result would not be the same: Thus each participant's contribution is important, smaller parts together that make up the whole process.

The empirical data in the online community in Study 3 unfolds through textual replies in discussion threads. This means that the interaction data are textual communications

deriving from the online community, not data from face-to-face communication, which has some implications. In face-to-face communication, body language plays an important role, such as gestures and tone of voice (for example a high pitch, an angry tone or a low tone). Textual communication in online communities is missing this context. An advantage of applying IA to textual communication deriving from discussion threads is that the dialogue and interaction are naturally occurring, and collecting the empirical data is convenient because one can collect it from the online data repository. When collecting the data directly from naturally occurring discussions in an online community, the biases that may occur in translation when transcribing interviews is diminished. However, one should also be aware of the potential use of hidden agendas and the use of fake identities in online communities, which may cause new problems. When performing IA analysis in Study 3, the focus was on turn-taking and detailed analysis of the social interactions. However, in hindsight, it could have enriched the analysis to also focus on the aspect of sense making, which also is a part of IA. Arnseth and Ludvigsen (2006) define sense making as the process by which different elements mutually shape one another and their meanings and functions are the results of local negotiation. It would be interesting in future research to also take this aspect into consideration when analyzing the mutual development processes in mass collaboration settings.

4.5 Reflection on research credibility

In this section, the credibility issues of the research project will be discussed, including reliability, validity, generalization and research ethics.

4.5.1 Reliability

Reliability has previously been known as a notion used in quantitative research for referring to the extent to which a variable or set of variables is consistent in what it is intended to measure. However in qualitative research, procedural reliability is related to consistency, typically meaning that another person should be able to examine the work and come to similar conclusions (Ihantola & Kin, 2011). One way of increasing reliability in qualitative research can be done by documenting the research procedures. In this dissertation, several efforts were made to increase reliability. First, when presenting the qualitative data in all three articles, it was a concern to present long data excerpts to provide a solid context. Hence, what happened before and after an interesting turn in the excerpt were included. This is in line with Silverman (2005) underlining that reliability is increased by providing descriptions that are as

concrete as possible, including verbatim accounts of what participants say and providing long data extracts that include the questions preceding a respondent's comments as well as the interviewer's questions. To increase reliability in Study 3 with regards to the quantitative data in the SNA analysis, I was careful to compare the findings with the qualitative data to ensure that the algorithms were being calculated properly. Second, during the data collection, strategies for increasing reliability included using technological tools to organize, document and analyze the datasets of the three studies. Third, in Study 3, a triangulation of methods was performed by integrating SNA and IA, which may have increased the reliability because two different datasets were examined, generating consistency in the interpretation and coding of the data. Reliability in mixed methods can be increased by keeping the qualitative components qualitative and the quantitative components quantitative during analysis to reduce the risk of misrepresentation (Tashakkori & Teddlie, 2010). Thus, when analyzing the empirical data, the qualitative and quantitative components were separated during analysis by conducting an SNA using the dedicated technological tool Ucinet (Borgatti et al., 2002). IA was also analyzed separately from the quantitative data.

4.5.2 Validity

Validity concerns whether the research is considered true and if it evaluates what it is supposed to evaluate (Silverman, 2005). When talking about validity, it is important to highlight that it is not the data themselves that are valid or not, but the inferences one draws from the data (Hammersley, 1983). To increase the validity in Studies 1, 2 and 3, focus was put on presenting empirical raw data at research meetings where the data was coded, screened and analyzed in collaboration with other researchers. This was conducted to reassure that the methods were applied correctly during the work with the empirical data. This dissertation focuses on the collaborative interactions emerging during the co-creation of a shared product or learning resource. Collaborative processes were thus central when selecting empirical data and writing the articles.

When conducting virtual ethnography in Studies 2 and 3, validity issues concerned subject position, taking care in initiating relationships with participants, writing field notes and organizing the data (Boellstorff, Nardi, Pearce & Taylor, 2012; Hine, 2008). As a researcher, one is to some extent always affecting the setting from which the data are collected. For example, in Study 3, the presence of the researcher in the discussion threads was made visible through an initial post that informed the participants about the purpose of the research (see Appendix 1). However, this may have led some participants to alter their

behavior. In Study 3, this potential bias was counteracted by selecting discussion threads that were dated six months back in time to capture historical records of the discussion threads and ensure that the interactions were naturalistic because they had been written before the researcher entered the community. All field notes were dated, titled and summarized. The steps in data reduction in all three studies, present a threat to the selection process. To overcome this, collaborative data workshops were organized in which raw data were coded and analyzed collaboratively with colleagues, providing multiple perspectives on the data. Working in small groups when conducting IA reveals and challenges the idiosyncratic biases of individual analysts (Jordan & Henderson, 1995). This also formed a quality check on the understanding of IA, particularly regarding which data excerpts were chosen for analysis and interpretations of the results.

A common limitation of qualitative research is confirmation bias, which means that one tends to interpret data based on patterns formed by previous data. It should be stressed that with an empirical dataset, there is always data that does not “match” or align with other parts of the dataset. Moreover, other researchers might be able to identify new patterns in the data, potentially seeing other things than those identified by a single researcher. This is often called confirmation bias or anecdotalism, which means that the empirical data consist of a few “well chosen” excerpts instead of a critical investigation of all empirical data (Silverman, 2005). To overcome this issue, in line with template analysis (King, 1994), in each of the intermediate terms or templates two or more examples from the data were collected to underline the common issue this code represented and show that they were not based on a deviant case or an anomalous situation. In addition, to account for how confirmation bias was counteracted, the selection criteria for the empirical data in the different studies reported in Articles 1, 2 and 3 were explicated in detail. The selection criteria also reflect the different phases of the processes of working with empirical data (see Figure 2 above). It was important to select data as scientifically and transparently as possible to increase the validity of the research. The template analysis that was used in all three studies advanced this goal.

Silverman suggests two ways of overcoming confirmation bias: a) method and data triangulation and b) respondent validation (Silverman, 2005). Triangulation means combining different ways of interpreting the data or different findings by combining different types of methods or techniques to corroborate different data sources (Silverman, 2005). To avoid making conclusions based on just one source of data in Study 1, different data types were collected, thus enabling viewing the phenomenon from different angles. As described in

section 4.2 and shown in Figure 2, a variety of methods for collecting, screening and analyzing the empirical data were used. As a result, this made it possible to correct the interpretation of one data source by drawing on the other as a complementary resource, e.g., to use qualitative empirical research to resolve conflicts in the quantitative analysis of the same data. This also helps reduce confirmation bias. Respondent validation suggests that the researcher should go back to the participants with a tentative interpretation and refine it in light of feedback from participants on the collected empirical data (Silverman, 2005). In Study 1, after several rounds of interpreting and analyzing the data, a workshop was organized with the participants where the tentative findings were presented. The participants could support or refute the interpretations of the collected empirical data. In Studies 2 and 3, the empirical data was captured from naturally occurring interactions in the online communities without the need for respondent validation with regards to whether the data were collected correctly, since the empirical data were used as is, unlike Study 1, which involved transcribing interviews. However, in retrospect, it could have been interesting to present the data and the interpretations of them to some of the central actors in the online community to get feedback on the study's accuracy in identifying recurring phenomena. Another central strategy for avoiding confirmation bias in the empirical data was participating in research meetings that focused on interpreting and analyzing the empirical data and the selection of data extracts in collaboration.

4.5.3 Generalizability

Generalizability is a standard aim in quantitative research and is usually achieved through statistical sampling procedures, whereas qualitative research includes two components to accommodate generalizability: *purposive sampling* and *theoretical sampling*. In purposive sampling, a case is chosen because it illustrates the feature or process of interest. In theoretical sampling, a case is chosen based on a theory, and deviant cases and sample sizes may be revised during the research (Silverman, 2006). In this dissertation, purposive sampling was used in all three studies, selecting cases that illuminated the co-creation of software products or learning resources. In educational research, it often is assumed that generalizations cannot be drawn from a small case study or a small sample of case studies (Silverman, 2006). Eisenhart (2009) disagreed and gave examples of generalizations that were made from qualitative inquiries, the most important of which were theoretical generalizations. The empirical findings emerging from the three case studies include a theoretical contribution (mutual development) and are therefore an example of theoretical generalization. The

theoretical generalization was supported in two ways: 1) the empirical categories originated in theoretical frameworks reported by other researchers; 2) with regard to transference, the research is framed within a sociocultural approach, which is a well-established approach, and made connections between the results and the theory. According to Eisenhart (2009),

In striving for theoretical generalization, the selection of a group or site to study is made based on the likelihood that the case will reveal something new and different, and that once this new phenomenon is theorized, additional cases will expose differences or variations that test its generalizability. The goal of theoretical generalization is to make existing theories more refined and incisive (Eisenhart, 2009, p.60).

The transferability of findings and results from one context to another is possible if the two contexts are sufficiently similar (Eisenhart, 2009). The selection of studies in Articles 1, 2 and 3 were made based on their similarity. This dissertation concerns studies in which social interactions were mediated by an online community and in which there was interaction and collaboration between end-users, champions and professional developers around further development of a software product (Studies 1 and 3) or between learners and course organizers in further development of a learning resource (Study 2).

4.5.4 Research ethics

In collecting the empirical data in Studies 1, 2 and 3, an ethical concern about informed consent emerged. Central in most ethical guidelines is the idea of informed consent (Silverman, 2006). Informed consent is defined as the obligation of researchers to reveal as much as possible about the nature, aim and methods of the study to the informants (Boellstorff et al., 2012). For Studies 1 and 3, written consent from participants was obtained. The participants were asked to sign an information letter as a reassurance that they had read the information. In addition, it was emphasized that the participants could withdraw from the study at any time. In Study 2, the second author provided the empirical data, which were accessible to anyone with internet access. Because these data did not contain any sensitive information it was considered unnecessary to obtain informed consent. In Study 3, I participated in the online community by writing a textual post in some discussion threads to make the participants in the online community aware of my presence as a researcher. In this context there was no direct intervening or interaction with the other participants in the community. On the opposite side, if one is a participant observant in a virtual online world, for example, in Second Life, he or she is visible to a much greater extent due to entering and walking around the world with a visible avatar that may be interpreted as a “intruder” (not

fully part of the community) in a greater sense than that which arises simply from reading discussion threads in an online community. In Study 2, a textual reply in the distinct discussion threads conveying information regarding the participation was not written. This was in accordance with the guidelines for research ethics set forward by The Norwegian National Committee for Research Ethics in the Social Sciences and the Humanities (2006), since the information in Study 2 was publicly available and not of a sensitive nature. However, in hindsight, a better solution could have been to also write a textual reply in each discussion thread that was used in the research project to inform the participants in the study.

In virtual ethnography, informed consent is challenging to obtain. This PhD project was reported to Norwegian Social Science Data Services (NSD) and therefore follows their ethical guidelines. All collected empirical data were stored in a locked cabinet and kept confidential. All names that could be traced to individuals were anonymized, so no one could be recognized. All the empirical data were anonymized by assigning fictional names to the participants. A passive consent message was created to inform the participants in Study 3 that the discussion threads would be downloaded to my computer for research purposes. Passive consent allowed the participants to withdraw from the study by sending an email if they did not want their contributions (i.e., statements posted in the online community) to be included in the research project. This message was posted in each discussion thread from which empirical data were collected in accordance with the guidelines set forth by the NSD at the time the studies were conducted (See Appendix 1).

5. Summary of the Articles

This chapter summarizes the three articles that are included in this dissertation. The articles present the empirical findings that constitute this dissertation. These findings will be summarized briefly. Each article reports a case study. Combined, the findings reported in these articles comprise the phenomenon of mutual development. The findings are further discussed in Chapter 6. The articles are presented in the order they were written, and all three articles are published. All articles were co-authored. The author declarations in Appendix 2 provide detailed explanations of the contributions of the first author.

5.1 Article 1

Andersen, R. & Mørch, A. I. (2009). Mutual development: A case study in customer-initiated software product development. In *International Symposium on End-User Development* (pp. 31-49). Springer, Berlin, Heidelberg.

This article examines how end-users and professional developers interact and collaborate in the joint development of an existing software product, which is mediated by the Customer Relationship Management system (CRM) in the company. The empirical findings were derived from a qualitative case study of a medium-sized company that sells project-planning software tools to the oil and gas sector in Norway. The research question that guided the data collection was as follows: How there is mutual development between customers and professional developers mediated by ICT support systems?²¹ EUD is closely connected to software development in several ways, but few studies have investigated EUD in which both two types of organizations are included in the development process: professional developers and the customers. The empirical data consisted of 10.5 hours of video material gathered from interviewing 11 participants. In Article 1, the main result is the identification and definition of *mutual development* as a process of interaction between end-users and professional developers in further development of a software product mediated by a CRM system that resembles an online community. The context is small group interaction. In processes of mutual development, five sub-processes of different constellations between end-users and professional developers were identified:²² 1) *Adaptation*, in which a customer requests an improvement to an existing product and the company chooses to fulfill the request, which then becomes a local adaptation to suit only this customer; 2) *Generalization* occurs when a new version of an existing product is made available to all customers; 3) *Improvement request* is a request from customers regarding extra functionality, bugs and usability; 4) *Specialization* occurs when the professional developers at the company create in-house builds; 5) *Tailoring* refers to end-users who make adaptations, hacks or workarounds on their own.

5.2 Article 2

Andersen, R. & Ponti, M. (2014). Participatory pedagogy in an open educational course: Challenges and opportunities. *Distance Education*, 35(2), 234–249.

This study investigated the ways in which learners and course organizers co-create tasks in a massive open educational course (MOOC), more specifically, a cMOOC facilitating interaction and collaboration. The context of this empirical study was an open informal

²¹ Article 1 was inspired by a previous work (Andersen, 2008) in which the author as part of her master's thesis participated in a case study in a large EU-financed project (Kp.Lab). I assisted in collecting the empirical data for the case study. The empirical data in Article 1 are analyzed in a slightly different manner by using an integrated EUD framework. The data are compressed, narrowed and focused to fit the scope of the study.

²² During a preliminary analysis, mutual development was initially formulated as *customer-initiated product development* (Andersen, 2008). In Article 1, the empirical data were analyzed based on a narrower and more fixed scope of interest, which resulted in using the term *mutual development*.

educational course in an online peer-to-peer university (P2PU). This is an informal educational context because it is an online community providing online education for which the participants do not receive formal credits for finishing the courses. The motivation for conducting the research reported in Article 2 was to examine one cMOOC and investigate how its learners and course organizers interacted and collaborated when participating in an MOOC and what the implications of enabling learners to be active contributors by co-creating course content in a cMOOC are. The research questions addressed in the article are: 1) What processes of interaction occur in an online open educational course? 2) What challenges and opportunities emerge? The empirical data consisted of all the activities generated by the participants in the cMOOC, called JavaScript, over a six-month period (one course period), which included where 160 messages were posted in an online community and the participants themselves created 32 tasks which was collected and analyzed.

The main contribution of Article 2 is identifying two processes of interaction between learners and course organizers when participating in the open educational course Javascript: “Problem identification” and “Co-creation of tasks.” In connection to this, two claims are made: that learners initiate and suggest learning content in the online course and that different starting points in programming knowledge create tensions regarding how to co-create tasks. Following this, the empirical data point at opportunities and challenges with participating in the cMOOC. The opportunities unraveled are that learners are empowered to be active contributors by initiating and suggesting course content to the course, as well as having the opportunity to co-create tasks. The challenges uncovered in the cMOOC in this study are that the learners (and course organizers) have different starting points for learning Javascript, which created tensions for how to co-create tasks. Two different directions for how to create tasks emerged: one for inexperienced learners and another for experienced learners, reflected in the data as different needs for how the tasks are designed. To conclude, the findings suggest that participation in the cMOOC is a complex social process where co-creating tasks is a collective activity in which different participants discuss, interact and collaborate.

5.3 Article 3

Andersen, R. & Mørch, A. I. (2016a). Mutual development in mass collaboration: Identifying interaction patterns in customer-initiated software product development. *Computers in Human Behavior*, 65, 77-91.

The advent of online communities has empowered ordinary end-users to become active contributors and content creators. This article examines the ways in which end-users, professional developers and champions interact and collaborate in further development of a software product, which is mediated by an online community. In this article, mutual development of a software product is investigated in a distributed and large-scale setting with a large number of participants: a mass collaboration context. The motivation for this study was to gain insights about how people interact and collaborate in an online community during mutual development of a shared artifact. Before the rise of online communities, only a small number of people created the artifacts and made decisions for many consumers (Fischer, 2011), but now with many online communities “everyone” can be part in creating artifacts. The research question guiding the inquiry was: “What are the patterns of interaction between end-users and professional developers in a mass collaboration community, as seen from a mutual development perspective?” This two-fold research question aimed to extend previous research (Andersen, 2008; Andersen & Mørch, 2009; Mørch & Andersen, 2010) and addresses interaction patterns in the online community and emphasizes identifying specific social practices in the community during mutual development. The first part of the question addresses the network level, that is, information paths and powerful actors, whereas the second part focuses on the interactions and collaborations between participants and what roles they perform in the mutual development process. In previous work (Andersen, 2008; Andersen & Mørch, 2009; Mørch & Andersen, 2010),²³ five sub-processes of user-developer interactions were identified at the small-group level, leading to the formulation of the term “mutual development.” In Article 3, these processes are extended by scaling up from small group collaboration to mass collaboration and integrating the methods of SNA and IA. The empirical data, which comprised all contributions marked as “share an idea” and “give praise” in the online community, were collected during a six-month period. The main finding of this study is the identification of four patterns of mass collaboration between three types of participants (end-users, champions and professional developers) in mutual development of a shared software product: 1) *Gatekeeping* is a process whereby an actor controls information by filtering and selectively choosing what information to pass on; 2) *Bridge building* is a

²³Seven utterances in the empirical data in Article 3 are also present in a previous workshop proceedings paper (Andersen, 2012), which was the first step in the preliminary analysis of the data. It should be noted that the theoretical concepts used in the discussion and findings are different from the former concepts, which focus on emotional qualifiers and not on SNA structural attributes. The seven utterances were included in Article 3 because of their prominence in the data. They were among the three most active discussion threads in the entire network. However, I could have included a reference to the workshop paper in Article 3.

process whereby a participant acts as a “gatekeeper” who distributes and shares information rather than withholding it; 3) *General development* occurs when a local solution (hack, modification or workaround) that was initially proposed by an end-user is brought to the attention of the professional developers at the company and is then integrated in the general product as a new feature, which means that it becomes available to all users; 4) *User–user collaboration* is a pattern of interaction in which customers create adaptations and tailor the product on their own (i.e., hacks, workarounds and solutions created by end-users) to fit the product to a new situation. This collaboration can take place either locally among the customers themselves or in collaboration with other users without involving professional developers in the process. The four patterns of interaction share some characteristics describing mass collaboration in mutual development: (a) asymmetrical power relationships (between end-users, champions and professional developers), (b) mass collaboration in the community is mainly initiated by end-users, but sometimes by champions and (c) different time scales: Interactions can last several years (General development) or occur in short, intense periods of collaboration that last from weeks to a few months (User–user collaboration).

6. General Discussion of Findings and Contributions

The focus of this dissertation is to examine artifact co-creation of a shared software product (Articles 1 and 3) or learning resource (Article 2) in small and large groups, in distributed online communities. Web 2.0 technologies that support collaborative, short and long-term iterative work provide the mediating computer artifacts, referred to as online communities. In this chapter, the main research question and the sub-research questions are addressed. This dissertation is empirically based because it uses empirical data as the starting point of the inquiry. In total, the empirical findings in this dissertation comprise a theoretical contribution with the notion “Mutual development,” identifying and exploring it with empirical examples in the studies. This chapter summarizes, compares and synthesizes findings across the three articles by addressing the main research question: “What characterizes the online collaborative processes in artifact co-creation where different participants interact and collaborate in further development of a software product or learning resource mediated by an online community?” Table 5 displays the answer to the research question by providing an overview of the characteristics of mutual development, which emerged in the three studies. As Table 5 shows, mutual development was the overarching predominant empirical and theoretical finding that emerged from the studies. Thus, it links the articles and provides

insight into interesting processes. Following this, a model of mutual development is presented (Figure 6). Then the empirical, theoretical and methodological contributions of the dissertation are discussed. Finally, the implications of the findings are suggested.

6.1 Mutual development as an empirical and theoretical contribution

The analysis and comparison of the empirical findings in the three articles revealed several cross-cutting characteristics of mutual development, as shown in Table 5. The purpose of Table 5 is to identify the integrating elements of the dissertation by summarizing, synthesizing and theorizing the concept of mutual development. The coherence of the dissertation is emphasized in the table by fine graining the characteristics of mutual development that are shared across the studies and were derived by analyzing the empirical data using the methods described in Chapter 4. I chose not to present empirical data excerpts in this chapter, since they are already presented and analyzed thoroughly in the articles. For more details on the empirical data supporting these characteristics of mutual development, see Articles 1, 2 and 3.

Table 5 shows the theory-driven concepts elaborated in Chapter 3 and the empirical variations of mutual development, which were revealed in the studies. In Table 5, the first column lists the theory-driven concepts with references to the authors who inspired me or introduced the corresponding characteristic. These concepts are referred to as “theoretical concepts” which provide the starting point for what to examine in the empirical investigations. However, not all terms in the left-hand column are theoretically motivated; some are merely common-sense concepts. Such terms are not supported by bibliographical references. The next three columns, headed Article 1, Article 2 and Article 3, represent empirical variations of mutual development that emerged from the empirical data analysis in the three studies. To the best of my knowledge, these variations are not theoretically loaded. I tried to stay as close as possible to the participants’ own wording when I described the phenomena to which the categories refer.

Table 5: Overview of the characteristics of mutual development

Characteristics	Article 1	Article 2	Article 3
<i>Interaction processes</i> (inspired by Engeström, 2004; Fischer, 2010; Jeppesen, 2004; Kahler, 2001; Scott, 2000; Victor & Boynton, 1998)	Mutual development of a software product in small group collaboration. Five sub-processes were identified: Adaptation, Generalization, Improvement Request, Specialization and Tailoring	Two different processes of interaction between learners and course organizers: Problem identification and Co-creation of tasks, using mutual development as a perspective	Mutual development of a software product in a mass collaboration context. Four interaction patterns were identified: Gatekeeping, Bridge building, General development and User-user collaboration
<i>Mediating computer artifact</i> (Säljö, 2001; Säljö, 2006; Vygotsky, 1978; Wertsch, 1991)	A Customer Relationship Management system (CRM)	An online Peer-to-Peer University Platform (P2PU)	An online customer community
<i>Participants</i>	End-users and professional developers	Learners and course organizers	End-users, champions and professional developers
<i>Power distribution</i> (Fischer, 2010)	Asymmetrical relation between end-users and professional developers	Asymmetrical relation between learners and course organizers	Asymmetrical relation between end-users, champions and professional developers
<i>Type of collaboration</i> (Cress, 2013; Stahl 2011; Tapscott & Williams, 2008)	Small group collaboration	Mass collaboration	Mass collaboration
<i>Time span</i>	Long (several years)	Short (ranging from one week to one semester)	Two time spans: 1) short (months) and 2) long (up to several years)
<i>Idea initiative</i> (von Hippel, 2005)	End-users take initiative and suggest improvements to a software product by issuing improvement requests to the company	Learners and course organizers take initiative and co-create tasks to be part of course content	End-users and champions initiate new ideas for how to develop the product further
<i>Trajectory of idea implementation</i> (inspired by Paavola	Idea is generated by end-users and integrated during the phase of	Idea is generated by learners or course organizers and are	Idea is generated by end-users or champions and integrated through the

& Hakkarainen, 2005; von Hippel, 2005)	“Generalization” into the general product	implemented as new course content through “Co-creation of tasks” in the open informal educational course	process of “General development” as a new feature integrated into an existing product
<i>Continually evolving artifact</i> (Fischer, 2010; Mørch et al., 2017)	Software product being developed is a continually evolving artifact	Task being developed is a continually evolving artifact	Software product being developed is a continually evolving artifact

The following is a brief explanation of the concepts in the left-hand column of Table 5. The term *interaction processes* reflects the theoretical sources that were used to analyze different sub-processes of mutual development in the articles (Engeström, 2004; Fischer, 2010; Kahler, 2001; Scott, 2000; Victor & Boynton, 1998). The term *mediating computer artifact* (Säljö, 2001; Säljö, 2006; Vygotsky, 1978; Wertsch, 1991) refers to how computer artifacts (the different online communities in the studies), being both tools and signs, consist of material aspects that are intertwined with interactions and collaborations when using the artifacts. *Participants* refer to the persons involved in the mutual development processes and their relationships. The term *power distribution* refers to who has the power to make the final decisions with regard to implementing ideas for further development and who has knowledge of the new features that are needed the most. The term *type of collaboration* refers to the processes of interaction and collaboration that emerge in mutual development: small group collaboration (Stahl, 2011) or mass collaboration (Cress, 2013). The term *time span* refers to the duration of the mutual product development process, which can range from weeks to years depending on the context. The term *idea initiative* is derived from the concept of user-driven innovation (von Hippel, 2005) and inspired by how lead users are the ones experiencing problems with existing products, which subsequently triggers further development of the product or learning resource. In processes of mutual development, there are no prefixed problems to be solved at the outset. The participants own the problems and the shared understandings of the problems that emerge during interactions and collaborations in conjunction with using the product, which leads to further development and new idea initiatives. The term *trajectory of idea implementation* (Paavola & Hakkarainen, 2005; von Hippel, 2005) refers to the path of how an idea “travels” in a network from idea inception to implementation in an altered product or learning resource. If the idea is successful, it may be

included in the next version of the existing product. The term *continually evolving artifact* (Fischer, 2010; Mørch et al., 2017) refers to the product being constantly developed, as not predefined or static but as continually evolving in different contexts. Two different directions emerged from the data: *radical mutual development processes* refer to processes in which the outcome of mutual development entails a radical change in the general product, such as implementing a feature initiated and suggested by end-users, which is made available to all. Conversely, *incremental development processes* refers to mutual development in which changes in the products are smaller alterations and modifications of the product, and often only made available to specific participants as local adaptations of the product. In subsequent sections, the information presented in Table 5 is elaborated based on the variations in mutual development obtained from the empirical findings of the three studies. In the following, the different characteristics of mutual development described in Table 5 are discussed in more detail according to the articles in which they appear.

Article 1: Mutual development in small group collaboration

Article 1 analyzed *processes of interaction* between end-users and professional developers in further development of a software product and defined the process of mutual development. The following sub-processes emerged from the empirical analysis: Adaptation (Excerpt 3), Generalization (Excerpt 4), Improvement Request (Excerpt 3) Tailoring (Excerpt 5) and Specialization. These processes were *mediated by a CRM system* that enabled end-users, as owners of problems, to make improvement requests. A characteristic of these processes was that they were user-driven. The *idea initiative* arose from the “Improvement requests” and “Tailoring” was derived from the end-users’ activities. Mutual development integrates the interactions of *end-users and professional developers*. The findings showed that EUD and professional software development were symbiotic activities; end-user activities nourished professional developers’ activities, and the software product evolved as a result. This relationship can be sustained in product-developing companies because they continuously need input and ideas from end-users to keep up with adapting products to customers’ needs, and sometimes customers themselves are able to perform local development on the products. The empirical data showed that there was an *asymmetrical power distribution* between end-users and professional developers. *Asymmetrical power distribution* refers to how the professional developers have the final say in deciding what ideas for new features to actually follow up and develop, though end-users are empowered to suggest new ideas for how to develop the software product further. The professional developers made the final decisions

about which suggested ideas to develop. Asymmetrical relationships can have embedded tensions that are derived from contradictory or unequal starting points with regard to the level of knowledge and the social position. There was not enough space to elaborate how the findings of mutual development in Article 1 are examples of small group collaboration and it is therefore expanded on here. Mutual development emerged in *small group interaction* processes in a workplace context. The knowledge-based aspects of this collaborative work among end-users and professional developers were similar to group cognition (Stahl, 2011), emphasizing how shared cognition emerges in small group settings when accomplishing joint cognitive tasks—in Stahl’s case, solving math problems and discussing alternative solutions (Stahl, 2011). In Article 1, the end-users experience problems with the products and therefore are the *problem owners*. The artifact co-creation processes in Article 1 included modifications of the product at several points, starting with an *idea initiative* that was generated by an end-user. The idea initiative triggered feedback from the participants and sometimes led to implementation of the suggested feature in the general product. These processes took place over a long *time span* of artifact co-creation and are an example of a *trajectory of idea implementation*. Therefore, the software product should be thought of as a *continually evolving artifact*, where the outcome of the mutual development process entailing a radical change in the general product, such as in the phase of “Generalization”. In addition, for example in the phase of “Tailoring”, more incremental changes are made to the product as local adaptations. Article 1 contributes to the research field of EUD by introducing the concept of mutual development and providing an empirical study of this phenomenon.

Article 2: Mutual development in an informal educational context

Article 2 investigates the ways in which different *participants* (learners and course organizers) interacted and collaborated in co-creating course content for a cMOOC. Using mutual development as a theoretical lens was helpful for investigating the events that occurred in the constellation between learners and course organizers when they had the opportunity to create new tasks for the open informal educational course known as *JavaScript*. The time span of these interactions ranged from one week to one semester, or the total duration of the course. Two *interaction processes* emerged from the data analysis: *Problem identification* (Excerpts 3 and 4) and *Co-creation of tasks* (Excerpt 5). The main finding from Study 2 was revealed when the mutual development perspective was used to analyze the empirical data. This finding illuminated two different pathways of active contributors co-creating course content: one pathway characterized the most experienced and skilled learners, and the other pathway

characterized the less experienced learners in the course. Both learners and course organizers took the *initiative* in co-creating tasks for the course content. The tasks that were co-created could become the focus of further discussion and modification and therefore *continually evolve* in response to feedback from learners and course organizers, which could materialize in both incremental and radical changes in the process of “Co-creation of tasks”. One example of co-created tasks can be seen in Excerpt 5. In Article 2, the *mediating computer artifact* is an online community in the P2PU that hosted the cMOOC. A cMOOC context implies *mass collaboration*. The concept of *mutual development* was helpful in understanding the gap between the less experienced and the more experienced learners in co-creating tasks that were suitable for both groups. The differentiation of pedagogical practices and didactics according to learners’ skill levels is a central theme in educational research, and it is relevant to MOOCs. The findings of Article 2 indicate the need for differentiating the varying roles (less experienced or skilled learners) of the participants. Such differentiation is referred to as the personalization or customization of the cMOOC. Article 2 contributes to the research field of distributed CSCL, particularly distance education, by providing a detailed empirical case study of a cMOOC.

Article 3: Mutual development in mass collaboration

Article 3 reports the analysis of the patterns of interaction among end-users, champions and professional developers in the context of mass collaboration mediated by an online community. These patterns revealed an *asymmetrical power distribution* among participants, which implied that professional developers decided what end-user ideas that would be developed. Article 3 expands the notion of mutual development to the broader context of *mass collaboration*, that is, large groups. This finding led to suggesting that *interaction patterns* are social structures that expand small group interaction, and four interaction patterns were identified and named: *Gatekeeping* (Excerpt 1) *Bridge building* (Excerpt 2), *General development* (Excerpt 3) and *User–user collaboration* (Excerpt 4). These interaction patterns spanned both *long and short time* periods of development, depending on the type of interaction pattern. An example of a short time span is “User-user collaboration,” in which end-users have brief but intense discussions about developing each other’s ideas for product improvements. Furthermore, “User–user collaboration” expands the sub-process of “Tailoring” from the original concept of “Mutual development” investigated in Article 1 to “User-user collaboration”. In “User-user collaboration,” end-users form groups to make local adaptations of a product. If these adaptations are taken up by professional developers, these local

adaptations may form *trajectories of idea implementation* and eventually become part of the general product that is available to all customers. This finding also indicates that the product is a *continually evolving artifact*; it is an object of constant development and feedback. In Study 3, the mutual development process in the phase of “General development” (see Excerpt 3) was characterized by long-term development, up to years, and the result of the mutual development process is that the suggested idea from the end-users is implemented into the general product and made available to all customers: characterized as a radical development rather than a smaller local workaround. However, in the phases of “User-user collaboration” (see Excerpt 4), minor changes to the product were proposed, characterizing an incremental development process. Another important finding is the emergence of a new user role, the champion, which will be further discussed in section 6.2.2.

The novel integration of SNA and IA was applied to analysis the data, which is further described in section 6.4. The three articles contribute to a better understanding of artifact co-creation processes that are mediated by computer artifacts through which different participants interact and collaborate in small group and mass collaboration. The articles have in common that they explore such collaboration as mutual development. However, the context differed among the three articles. This difference reflects the evolution of the dissertation and defines the trajectory of the research process. This PhD project started with Article 1, exploring the relationship between end-users and professional developers in developing a product that was mediated by a CRM system, which led to the definition of mutual development. In Article 2, the relationship between learners and course organizers was followed up and examined in detail, where mutual development is taken one step further by placing it in an informal educational context, being a cMOOC, which was mediated by the online P2PU community. In Article 3, the focus was on understanding the complex relationships that emerged between end-users, champions and professional developers when several thousand participants are enabled to interact. This PhD process reflects my increased understanding of the complex, interrelated and multifaceted relationships emerging between end-users, champions and professional developers when mediated by a computer artifact (e.g. online community), which is termed *mutual development*. In the next section, a model of mutual development is presented. Article 3 contributes to the research fields of online communities and EUD.

In this section, some common critical reflections applying to all three case studies are presented. Combining these different characteristics into one definition of mutual

development is not without tensions. When combining different empirical data some issues will necessary emerge. One apparent issue with regards to Table 5 is that there are different amount of empirical data available from small group collaboration and mass collaboration, which creates some tensions in connection to methods. One implication of this is that the same methods could not be used in all case studies, but, as explained in Study 3, another method was needed to be able to conduct justified and scientific analyses of the large amount of data. This was solved by using template analysis in all the articles as an overarching method for screening the empirical data, emphasizing qualitative methods. The focus in this dissertation is the co-creation of artifacts, revealing two different types of co-created artifacts: software artifacts (Studies 1 and 3) and knowledge artifacts with focus on co-creation of tasks (Study 2). Even though the studies differ in this matter, they are all anchored in the sociocultural perspective. Study 2 highlights a tension between the less experienced and more experienced participants in the cMOOC, which becomes problematic when participants are expected to co-create course content, since some create tasks that are too difficult for others to solve and others create tasks that are too easy. The same tension can also be seen in Study 3, where end-users in the online community naturally have different backgrounds and experience with the product, affecting their ability to evaluate the quality of the suggestions of ideas for further development of the software product. However, this is not an explicit focus in the study since the dissertation has a process focus. When end-users suggest different ideas for how to develop new features of the software product or learning resource, it reflects their background and experience with the product. As a result, tensions might emerge with regards to the quality of the feature requests. However, this is not very problematic or foregrounded in Study 3 because there are no immediate negative consequences if an end-user suggests and idea that is not followed upon (because it is considered an unviable idea); nothing really happens. Conversely, in Study 2, if the created tasks are too difficult to solve, it has consequences for all the participants in the course. In the next paragraph the different characteristics of mutual development presented in Table 5 are compared and contrasted.

6.1.1 A model of mutual development

Below, a model of mutual development in small group and mass collaboration is presented (see Figure 6). This model has never been published before, and to the best of my knowledge, no similar known models exist. Researchers use models to represent and understand aspects of the world. This model points out how mutual development has shared characteristics across cases that can be derived from the studies in this dissertation, though these characteristics are

slightly different depending on the context. The aim of the model is to crystallize the processes of mutual development and to visualize the relationship between these processes, deriving directly from Table 5 and reflecting the empirical findings of Studies 1, 2 and 3. The model is useful because it aims to envisage and ascend to a more abstract level, depicting common traits of mutual development that emerge in small group collaboration and mass collaboration settings.

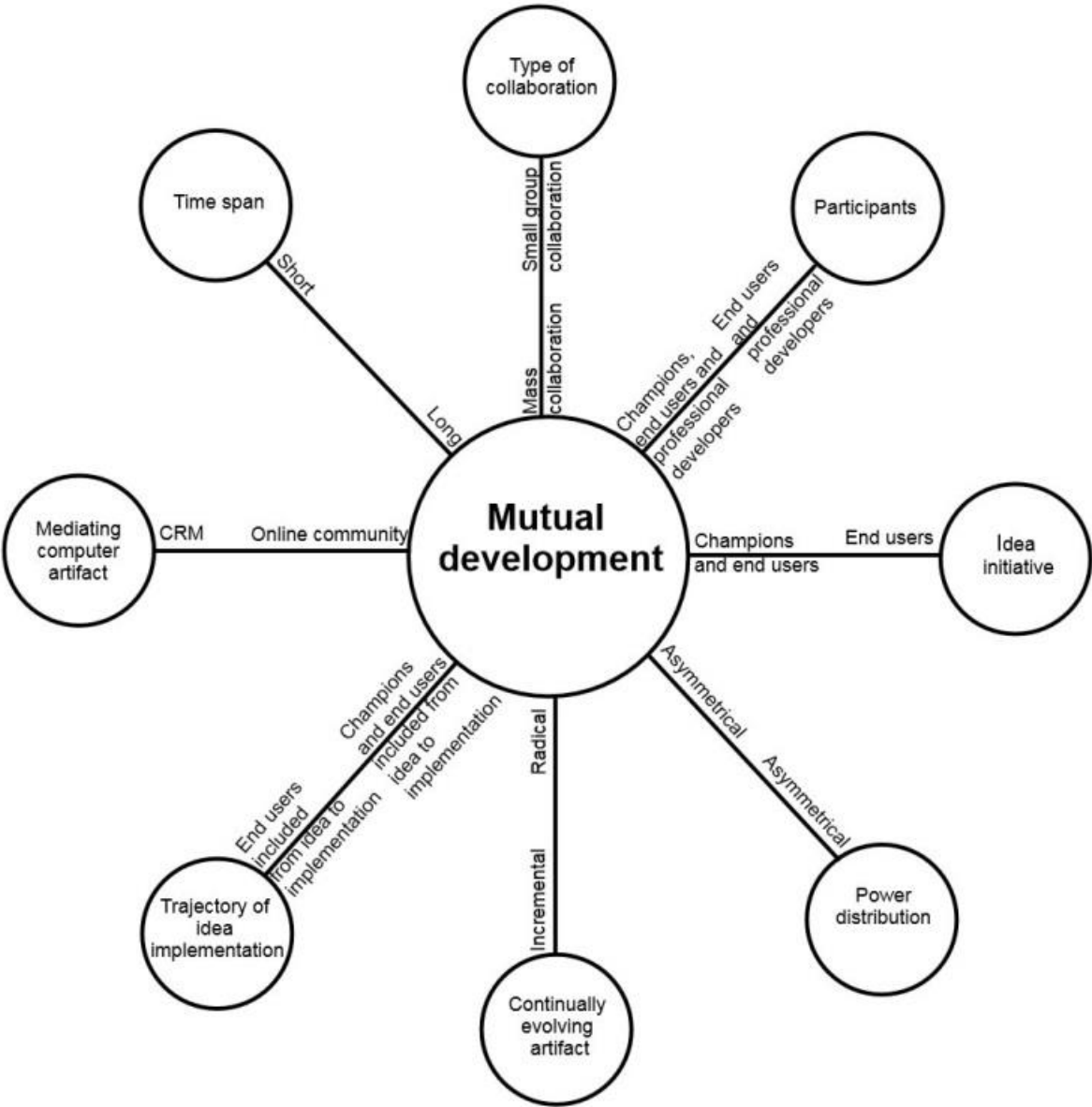


Figure 6: Model of mutual development and its variations in characteristics, in small group collaboration (toward outer circles) and mass collaboration (toward inner circles)

Models are the primary tools of representation in many sciences and are designed so that the elements of the model can be identified with features of the real-world phenomenon that is being modeled (Giere, 2004). This dissertation uses the definition of a model provided by Giere (2004), to create and justify the model of mutual development shown in Figure 6. How the purpose of a model is defined depends on one's worldview and epistemology. From the epistemological point of view, I apply the notion of model as a representational tool, according to a sociocultural perspective. The main point that Giere (2004) makes is that a model is an idealization of the object of study, focusing on some dimensions and leaving out others. An important characteristic of a model is its aspect of similarity. Scientists select specific features of a model that are claimed to be similar to features of the designated real system to some degree of fit (Giere, 2004). Table 5 is the fundament for creating the model of mutual development. As a model, mutual development operates in two different contexts: small group collaboration and mass collaboration. It promotes and considers the continuum and range between the empirical variations, which are represented as two opposite endpoints (contexts) in the model. The characteristics closest to the center of the model represent elements of mass collaboration, whereas the characteristics closest to the periphery (i.e., on the other side of the continuum) represent elements of small group collaboration. This demarcation foregrounds mutual development as a phenomenon that occurs in both contexts and embodies a set of features. These features are represented as a continuum between two opposite ends of a scale because their characteristics did not have clear affiliations. They are not mutually exclusive. Depending on the context of the case, the features varied along the lines of the continuum. For example, in a mass collaboration context, the characteristic "time span" was not only limited to short-term periods of development, but also consisted of periods of long-term development. With Table 5 as a backdrop, the most central components were selected and represented in the model above. The model does not illustrate the specific empirical variations in Articles 1, 2 and 3 (this is the purpose of Table 5), but it represents more general characteristics of mutual development at a higher level of abstraction.

Models are an idealization of real world phenomena, as explained by Giere (2004), which means that they to a certain degree are simplified to be more understandable, serving as an analytical grip. This means that some of the complex nuances in mutual development identified in the empirical data are left out from the model but described in the articles. For example, some different constellations of interaction and collaboration between the participants in the different sub-processes of mutual development were purposively omitted

from the model but are present in the articles. For example, in the “User-user collaboration” phase in Study 3 (Excerpt 4), only end-users were collaborating on further developing the product further, whereas in the phase of “General development” (Excerpt 3), end-users, champions and professional developers are all part of the interaction process. The four most prominent and interesting empirical findings, reflecting some of the elements in the model of mutual development described above, are further discussed below and connected to the research questions.

6.2 Empirical contributions

Two empirical contributions of this dissertation are discussed and analyzed in this section: 1) the trajectory of an idea implementation and 2) the new user role of champion. These contributions are discussed using concepts mainly derived from the conceptual framework (Chapter 3). Concepts that were revealed in the literature review (Chapter 2) are also discussed. These empirical contributions can be viewed as results or outcomes of the research on mutual development in online communities explored in this dissertation. This section addresses sub-research question 1, which is an empirical question: “What are the implications of mutual development for interaction and collaboration in online communities?”

6.2.1 Trajectory of idea implementation

Trajectory of idea implementation is a specific example of an empirical process emerging in mutual development in an online community. Trajectory of idea implementation shows how collaboration in online communities creates new opportunities for how an initial idea can evolve from its inception to implementation in a software product (Studies 1 and 3) or learning resource (Study 2). Across all three studies, a common finding is the identification of how end-users generate an idea, how it develops through a network of collaborating participants and how it sometimes ends up being implemented in the already existing product. This process is defined as the *trajectory of idea implementation*, which involves following up on ideas in an interactive and collaborative process that involves different participants (for example: end-users, champions and professional developers). In these mutual development processes, the participants responded to the suggested ideas and contributed alternative solutions by building on previous responses, and in some situations the idea began “living its own life” in the community. In Articles 1, 2 and 3, the empirical data analysis showed that ideas about developing a product further often originated from end-users, champion or learners, meaning that ideas are initiated and partially propelled by them. End-users suggested

new ideas through for example “Improvement requests” (Article 1), or through creating tasks for the ongoing course in the cMOOC (Article 2) or through sharing new ideas for further developing the software product (Article 3).

An example of the trajectory of an idea implementation is Excerpt 3 in Article 3. In this trajectory, Champion 1 proposed an idea for the new feature, “Add notification preferences that are product specific,” which was followed up on by a professional developer who stated that this was “a planned feature,” indicating that it would be developed. Next, an end-user became involved in the interaction and initiated collaboration by extending the originally proposed idea to provide a better or more elaborate description of how the product could be developed, which was supported by another end-user. Within a long time span (up to several years), several end-users and champions asked for the status of the idea by expressing their need for having the requested feature developed. As a result, a champion answered by providing an update on the status of the idea as “being loaded up in our feature request queue” (Champion 7). Another champion then supported the idea. Over time, another end-user provided an alternative solution to developing the suggested idea, which was followed by another end-user describing yet another solution to this idea. Then, a champion answered by stating, “Sadly I don’t have an exact time frame for when this get released” (Champion 8). Finally, a professional developer announced that the idea had been implemented in the product and that it would become part of a future release (general product). Figure 7 provides a visualization of the trajectory of an idea from initiation to implementation and realization by visualizing the nonlinear process of a trajectory of idea implementation in mutual development of a product or learning resource, emphasizing how the processes occur in several rounds. In addition, Figure 7 is useful since it underscores the importance of also taking the participants’ roles into consideration when focusing on mutual development of an idea to a new feature. The participants are differentiated by color and shape: end-user (green and no hat), champion (blue and a triangular hat) and professional developer (purple and a square hat).

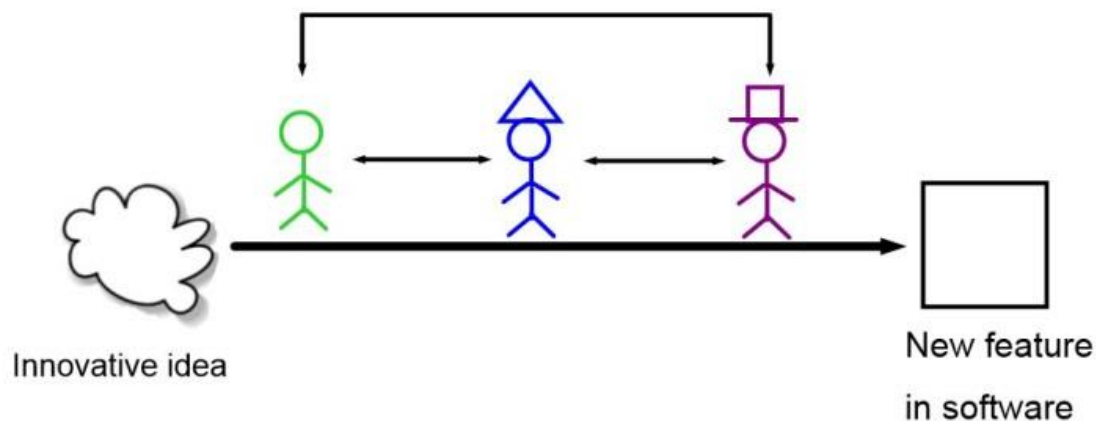


Figure 7: Trajectory of idea implementation

This dissertation builds on and extends previous work on user-driven innovation (von Hippel, 2005) by presenting the trajectory of idea implementation from an innovative idea to an implemented idea as a feature of a future product release. The model of mutual development (see Figure 6) emphasizes that different participants contribute to the innovation and further development of an existing software product or learning resource in collaboration with several participants. This has similarities to the private-collective model of innovation (von Hippel, 2005), which emphasizes that a company gains profit from its innovative end-users. This is often referred to as an alternative way of envisioning innovation processes emphasizing that by turning the process around and making the proprietary innovation freely available, enabling a crowd of people to innovate, it may result in gained profits from increased revenue from innovation ideas (von Hippel, 2005). In this dissertation, the mutual development model differs from the private-collective model in how suggested user-initiated ideas are implemented in the existing product. In the private-collective model, there is no filtering process for the ideas suggested by end-users, which means that this model resembles an aggregating model. In Articles 1 and 3, a prominent finding was the fine-grained and detailed analysis of the process concerning the features that derive from the end-users. All proposed features are not merely added to the general product. This finding implies that user-generated ideas go through a selection process in the company, where the professional developers have the power to decide what ideas to follow up, develop and implement. In Article 3, the selection process began when an end-user proposed a feature to be developed. If the idea was viable, a professional developer usually responded within a short time by placing it in a category of “planned”, “not planned”, “under consideration” or “implemented.” Next, end-

users and champions reacted to this response by collaborating and suggesting modifications to the originally proposed idea. Then, depending on the number of end-users that interacted and collaborated in co-creating the idea further, a champion intervened and sometimes supported the end-users, such as by stating, “professional developers, this feature is needed” or “an idea for further development is this and this.” After a considerable amount of time, the professional developers reentered the discussion and described the status of the idea, such as “a planned feature” or an “implemented idea.” This finding is an example of how professional developers can filter, fine grain and channel the incoming improvement requests for further development of the software products. In Article 3, the analysis of the processes around user-generated ideas revealed a new user role of champion, which will be described in the next section. However, a limitation with Figure 7 is that it does not show the filtering processes that occur during the idea implementation trajectory. To make the model understandable and keep it from becoming too complex, these processes were taken out, but it remains important and is therefore discussed in the corresponding articles.

6.2.2 Champion as an emergent user role

A central finding of this dissertation is the identification in Article 3 of champions as a new user role that acts as an intermediary or moderator between end-users and professional developers. In Article 3, because of space constraints, the role of champions was not discussed in detail; therefore, it is elaborated here. The user role of the champion emerged from ordinary end-users who were designated as champions by the company because of their long-term commitment to the online community.²⁴ Champions were characterized as active contributors to the online community by providing ideas and solutions for further development of an existing software product. The fact that there were approximately the same number of champions (47) as employees (50) for handling a massive number of participants (269.280) indicates that the champions played an important role in the company (see Table 3 in section 4.2.1). Champions gained social status by receiving a “champion” icon and badge, which were placed next to their username in their profile, thus increasing their social capital in the online community. In the company, the champions’ tasks were two-fold, and these users dynamically switch between the two modes of work: 1) volunteer activity that resembles the task of an administrative or support person who represents customers; 2) part-time employees and technically skilled actors who provide solutions to end-users’ feature

²⁴ Inspired by Article 3, I and Anders Mørch published a short paper on champions as a new, emergent user role (Andersen & Mørch, 2016b).

requests. This finding implies that utterances by champions are not entirely motivated by customer needs; they also have an interest in sustaining the company's assets. One critical perspective in connection to this is the tension that is embedded in the nature of the dual roles of champions, acting as both end-users and part-time employees of the company. Champions share commonalities with lead users (von Hippel, 2005), who are described in section 3.3. Lead users are defined as members of a user population that has two characteristics: 1) They anticipate obtaining relatively high benefits from gaining a solution to their needs and may innovate to gain access to these benefits as soon as possible; 2) they are at the leading edge of important trends in the marketplace and therefore perceive needs that will later be experienced by many users (von Hippel, 1986). The role of the champion also resembles the notion of super users, who are end-users who tailor products to suit their own needs (Åsand & Mørch, 2006). However, champions represent a new user role transcending the boundaries of traditional super users and lead users in that they actually get appointed as part-time employees due to their competence as domain expert users and all the spare time they have spent benefiting the company by responding other end-users' feature requests and issues with the product.

6.3 Theoretical contributions

In this section, two theoretical contributions deriving from the model of mutual development are presented. The online communities that mediate the interaction and collaboration is central to the mutual development process. Therefore, online communities can be interpreted as computer artifacts, and as continually evolving computing artifacts. I interpret the theoretical notion of computer artifact as being two folded: First, it can be viewed from a sociocultural perspective emphasizing how computer artifacts mediate actions in the world. Second, interpreting the notion of computer artifact from an EUD perspective implies an emphasis on the evolutionary aspects of computer artifacts. This section addresses sub-research question 2, which is theoretically oriented: "What characteristics of mutual development can be derived from a theoretical framework?"

6.3.1 Computer artifact

Computer artifact is a general and abstract term and is connected with computer-mediated interaction, as in online communities. *Computer artifact* as a term is not described to a great extent in recent research literature. The reason may be that when the notion of *artifact* was defined, computers and online communities did not exist; therefore, the term was not

considered. In the sociocultural approach, the theoretical concept artifact has a general definition that includes two types of artifacts (see section 3.1.2): abstract (i.e., language, signs and symbols) and concrete (i.e., hands-on tools such as a hammer and pencil) (Vygotsky, 1978; Wertsch, 1991). Säljö (2001) emphasized that although signs in artifacts consist of meaning, they presuppose that the interpreter and user of the artifact understand the meaning of the artifact. The user of the artifact needs to understand the meaning of it in order to understand the idea or rationale behind it to make sense of how it is used. With regard to the focus of this dissertation, it is necessary that participants in online communities are enabled to and capable of using the computer artifacts given to them: They need to be able to interpret the meanings or codes embedded in the computer artifact. Furthermore, within the practices of educational research, discourse tends to downplay the material side of computational artifacts. In this dissertation, the computer artifacts mediating the mutual development processes are: a CRM (Article 1), an online P2PU (Article 2) and an online community (Article 3). Table 5 shows the characteristic defined as “*mediating computer artifact*”, providing an overview of computer artifacts in the three studies. These computer artifacts are computer-based which has implications for social practices, end-user modifiability (evolving artifact characteristics) and patterns of communication and collaboration. The implications of mutual development as computer mediated by online communities are elaborated in section 6.5.1. The findings from the three studies in this dissertation indicate that a computer artifact can be characterized as not only a complex artifact but also one that allows for much more modification than predecessor artifacts. Computer artifacts have technological functions that afford different types of usage, such as interaction, collaboration and modification. Thus, in the mediation process of a computer artifact, the divide between the concrete tool and the abstract sign is not clear. The computer artifact is both a physical tool and a set of built-in abstract signs (i.e., program code). The material affordances of computer artifacts that are common across all three studies are as follows: (a) facilitate interaction and collaboration, (b) provide instant feedback and (c) provide incentives and tools for active participation.

The online communities in the studies mediate mutual development and have built-in functionality aimed at facilitating collaboration for this purpose. This functionality of the online communities is briefly discussed here, as it provides important contextual information for understanding the details of the mediation process. In mutual development, end-users and other participants in software product development express their opinions in several ways on how the product or learning resource should be further developed. In Studies 2 and 3, this

occurred as participants created discussion threads and replied to each other's comments in the discussion threads. These online communities were structured as textual messages and replies posted in the community. As a result, the communities functioned as mediating computer artifacts by providing a common online space for mediating interaction and collaboration among the participants.

The online communities are (in the three studies) open communities in which participants can be active by creating new discussion threads and contributing to existing threads, and the different studies have different degrees of formalized structure built into the technological tool. For example, the CRM tool in Study 1 was highly structured because it provided very few options for how users could be active and contribute. One could post a question to the system and tag it with, for example "Improvement request," etc. In Study 2, there was a much looser structure imposed, where learners and course organizers could create tasks and discussion threads in what ways they wanted. For example, it was not a requirement that the user had to tag new discussion threads with a topic when creating them. In Study 3, messages had to be tagged according to one of four prefixed topic categories: "share an idea," "give praise," "ask a question" and "report a problem." The built-in structure in the online communities provided an indication of the activity carried out by the participants. Seeing the online communities as computer artifacts, when viewed from a sociocultural perspective, indicates how computer artifacts may change human behavior. Thus, the structure of the online community may shape the ways the participants use and create discussion threads. If the preexisting categories with which to tag ideas are broad enough, this works well as a structuring mechanism. However, it can also narrow the choices too much and decrease activity and creativity, which is the opposite of fostering active user participation.

6.3.2 Continually evolving artifacts

In all three studies, the findings showed that the artifacts in co-creation processes continually evolve. In their further development, new features are added to existing products or learning resources to improve them, foregrounding that a continually evolving artifact is a central characteristic of mutual development (see Figure 6). Fischer (2011) referred to the potential of "the unfinished," and takes into account that design problems have no stopping rule, they must remain open and fluid to accommodate changes in the user environment. Hence, they can be characterized as being in a state of "perpetual beta," that is, an always open, continually evolving system (Fischer, 2010). An example of how a product continually evolves is given in section 6.2.1, where the trajectory of an implemented idea is presented.

Other frameworks for the evolution of artifacts are the evolving artifact approach (Mørch, 1997a; Mørch, 1997b; Ostwald, 1996) and the evolving artifacts framework (Mørch et al., 2017). These frameworks shed light on evolutionary aspects of artifacts in artifact co-creation processes because they include them as a unit of analysis but do not apply rigorous empirical methods or focus on what occurs in the collaborative development of a shared artifact in the co-creation process, as is the case in Article 3. The affordances and constraints of an artifact in a co-creation process allows end-users to contribute to the development in collaboration with professionals. In investigating the factors that make participants willing to contribute by modifying “a never-finished product,” it is useful to examine the techniques that empower the different participants to participate in the continual development of the product. In all three studies, the end-users were content creators, a finding that emerged from the empirical data analysis through trajectories of idea implementation (section 6.2.1). In Article 1, *meta-design* (Fischer, 2010) is a central concept in understanding the active inclusion of end-users in the product development process, with distinctions being made between design time and use time. In meta-design, the Seeding, Evolutionary growth and Reseeding (SER) model is used to analyze empirical data (Fischer & Ostwald, 2002). The software computer artifacts are viewed as seeds that continuously evolve in response to collaboration between end-users and professional developers. A potential limitation of meta-design and the SER model is that it only allow for end-users to be included in the development process at the design-time or use-time. In contrast, in Articles 1, 2 and 3, the end-users were active in all phases of the development process except the final execution phase that involved the professional developers performing “General development” in restructuring the software for a new compact release. The focus of modding differs because it promotes direct contributions by participants who make technical changes without the involvement of professional developers at any time in the process (El-Nasr & Smith, 2006; Jeppesen, 2004; Sotamaa, 2010). Modding is related to the “User–user collaboration” process that emerged in Article 3 and “Tailoring” from Article 1. The similarity of modding and tailoring was addressed by Mørch (1997a). He defined three levels of tailoring according to their complexity (i.e., ease-making modification), and two of these levels, integration and extension, accommodate mods. However, he did not focus on modding as a collaborative activity because modding is not primarily a collaborative activity, and modders often work alone. In Article 3, the empirical data analysis revealed that end-users created local workarounds to the product by collaborating, which resembles collaborative tailoring (Kahler, 2001). To understand the relationship between participants

who suggest changes to a shared computer artifact, the concept of *co-configuration* was introduced to focus on collaboration in further development of a product (Engeström, 2004; Victor & Boynton, 1998). In Articles 1, 2 and 3, several examples were provided pointing at how end-users and professional developers interact and collaborate in the continually evolution and co-configuration of a product in line with Engeström (2004) and Victor and Boynton (1998).

6.4 Methodological contribution

The main methodological contribution of this dissertation is its integration of two different methods to analyze mutual development in mass collaboration, stemming from Article 3: SNA and IA. The methods derive from two different research traditions: SNA represents a quantitative approach and IA a qualitative approach. Integrating two different research traditions is not necessarily easy, but the mass collaboration context in Study 3 necessitated a method that could handle large datasets of up to several thousand participant utterances. SNA was selected as an appropriate method because not only is it used to study large datasets from a quantitative social science perspective, but it also focuses on the relational aspects of the participants' interactions in a network or community (Scott, 2000). The mathematical measurements of SNA enabled identifying the power aspects that were latent in the online community by using degree centrality and betweenness centrality (Scott, 2000). The former revealed the "selection power" (i.e., the number of messages posted in the discussion thread) and the latter revealed the "control power" (i.e., how many other persons were dependent on this specific person to connect with other users in the network). Applying SNA to the empirical data yielded important information for making choices regarding what discussion threads and participants to examine in detail at the interaction level. This section addresses sub-research question 3, which is a methodological question: "What methods are appropriate for collecting and analyzing empirical data on mutual development in small group collaboration and in mass collaboration?"

SNA was used in two ways. It was used to select the criteria for providing a scientific foundation, and it provided arguments for choosing the excerpts that were included in the empirical data. The empirical data used in Article 3 were selected based on the SNA measurements applied to the entire dataset. After a list of the top 20 most central discussion threads was calculated, the three discussion threads with the highest activity, measured according to degree centrality, were chosen for deeper analysis. Twenty discussion threads were selected based on this measure since it gave a good overview among the total of 41

discussion threads. This was a manageable amount of data to analyze and present in the article. These top 20 discussion threads were screened with the research questions in mind to make sure no data was overlooked. There is a small possibility that some interesting discussions were not included in the top 20 discussion threads because their centrality and betweenness were overlooked. However, it was assumed that having identified the top 20 most active discussion threads to some degree reflects that there are some common topics of interest and relevance being discussed among end-users and professional developers. It was not taken for granted that the quantitatively most central and active discussion threads were the most interesting ones from a qualitative perspective. Therefore, several other discussion threads were also screened from a qualitative perspective. Applying SNA as a zoom on the empirical data provided a macro overview of the empirical data, where an overview of all of the data in the whole large data set was taken into consideration. Because the SNA data could not reveal the content of the discussion threads, IA was used to delve deeper into the concrete interactions that occurred in the discussion threads. IA is a framework for analyzing how talk and physical activity are intertwined in a turn-taking system when investigating human activities, such as talk, nonverbal interactions and the use of artifacts and technologies (Jordan & Henderson, 1995). Therefore, IA was applied for the in-depth analysis of selected empirical data from a qualitative perspective.

In summary, the empirical data were analyzed on two levels: (a) The macro level (SNA) yielded an overview of all the empirical data; and (b) the micro level (IA) provided detailed explanations of selected parts of the empirical data. This gave a fuller understanding of the phenomenon of mutual development than either method by itself could have done. SNA and IA were mixed during the collection of data (first SNA data collection occurred, and then the IA data collection) and during the analysis of data (SNA and IA analysis occurring simultaneously) by an extended IA table (See Table 1 in section 4.1.3). This integration of SNA and IA is the methodological contribution of this dissertation, adding to the current literature on mixed methods research. The version of mixed methods research applied in Article 3 parallels the criteria for integrative mixed methods research as suggested by Bazeley (2017). As elaborated in Chapter 4, the integrative mixed methods research employed when combining SNA and IA can be classified as a hybrid strategy (Bazeley, 2017), which is a strategy that inherently combines both qualitative and quantitative elements to create a single source or set of data that is further examined using iterative qualitative and quantitative strategies (Bazeley, 2017). In this dissertation, the methodology that I applied could be further

classified as a methodological bricolage (Bazeley, 2017). This term reflects the exploratory nature of the studies in this dissertation, particularly in its purpose being methodological piloting and innovating when testing out new methods.

6.5 Implications

In this section I will propose some implications of this dissertation to the research fields to which this study aims to contribute, EUD, CSCL and online communities. One implication for the fields of EUD and online communities is identifying the *”Trajectory of idea implementation*, which underlines how end-users are enabled to be active contributors and content creators in potentially all phases of the software product development process (except the final execution phase in which the ideas are implemented by the professional developer or course organizer). As a result this transforms how the software product development process unfolds by pointing at new and different constellations of collaborating and interacting participants. Consequently, the traditional divide between end-users and professional developers, and learners and course organizers, become blurred. Another significant implication is the emergence of a new user role: *champions*. The role of champions has implications for user-driven innovation studies and the field of EUD because it indicates that lead users are not the only instigators of innovations (von Hippel, 2005). Hence, champions could be an important source for driving the mutual development processes forward.

The findings also have implications for CSCL and distance education when considering the relationship between learners and course organizers in cMOOCs in which co-creating tasks is part of the course content. Even though MOOCs are the “new thing,” not much scientific research has investigated what occurs in them or their implications for the educational setting. Several questions are raised: Are MOOCs disrupting traditional education by turning the educational process “upside down?” What are the benefits of including and demanding end-users to be co-creators of course content in cMOOCs, which was examined in Article 2? One central question that remains unanswered concerns whether the quality of the tasks created by the learners (and in collaboration with course organizers) meets educational standards. The findings in Article 2 showed that the experienced learners in the cMOOC created more complicated tasks. Consequently, a tension emerged between the less experienced learners who needed easier tasks to solve and the more experienced learners who wanted difficult tasks. By enabling strong and resourceful learners to be part of co-creating tasks, are MOOCs becoming an educational approach for prioritizing elite learners and leaving behind slower learners? These pedagogical and didactical implications raise the issue

of the differentiation of resources, which must be addressed to prevent drop-outs and wasted time and effort. The cMOOC in Study 2 is characterized as an informal learning context, because it does not give credit points when participants complete it, implying that one can drop out at any point without any consequences. The learners can come and go, and they are not obliged to participate. However, there exist MOOCs that are provided within a formal educational framework. The distribution between formal and informal learning in MOOCs can be blurred. However, this is out of scope for this dissertation but could be an area for further research. The findings indicated that a product or learning resource that was the focus for further development through interaction and collaboration was continuously evolving. In contrast to traditional collaborative development processes in which a software product or learning resource often is prefixed, “finished,” and ready for distribution to the participants, it has transitioned to being an “ever-changing product or learning resource.” However, the following questions need to be addressed: How can it be ensured that end-users continue to provide the company with ideas for improving products? To what extent can the continually evolving software product or learning resource be expanded before it reaches the limit of maximum available features? In the context of mass collaboration, one implication of the findings concerns the effects of “word mouthing” (Kozinets, 2010), which refers to defending the company in online communities, for example when working towards becoming a champion. Another implication is that when customers are empowered to co-create products, they also are helping the company (Kozinets, 2010), and this may trigger part-time (paid) employment. A final implication of the findings that emerged in this dissertation is that SNA could provide a useful tool for companies to identify the most active contributors and the most powerful participants in their online community, and combining this with detailed interaction data can reveal important mutual development processes.

6.5.1 Implications of mutual development as computer mediated by online communities

In this section, two implications of mutual development are discussed: 1) computer mediated and 2) mediated by online communities. There are at least two different contexts in which *computer-mediated interactions* can unfold: co-located and distributed. Co-located computer-mediated interaction refers to situations in which learners are physically located in the same place. An example is the use of ICT in classrooms during group work, when students are physically located in front of the same computer creating a wiki or learning how to use Minecraft in a classroom. Co-located interactions are not the focus of this dissertation. In contrast, the focus is on distributed collaboration, meaning that participants are distributed in

time and geographical location. One implication of the process being in a distributed setting is that it opens up the process. Participants in distributed computer-mediated contexts decide for themselves when and where they will participate; such processes are flexible with regards to time and place, as long as users have access to a computer with an internet connection and are registered as participants. This may lower the threshold for participation and thereby make it easier for participants' to be active contributors. In addition, the distributed setting enables collaboration between a large number of participants as they do not occupy the same physical space. The co-located setting in classrooms is restricted in both time and geographical location. However, there are some limitations of distributed computer-mediated interaction as well. First, some participants may not be as motivated to engage in social interaction when one is not co-present. Second, not all people who are "participating" (e.g. logged on) in the online community may want to be active in the mutual development processes. In a computer-mediated and distributed setting, one cannot prevent "lurking" and observing. A third limitation is that when a large number of people are gathered in an online community, they will most likely not know each other, and real identities may be hidden behind fake profiles, which may hinder fruitful interaction and collaboration.

Mediation by online communities has implications for the mutual development process. The online communities in Studies 2 and 3 are designed with features (e.g., discussion threads, connecting to social media profiles) to motivate participation and facilitate collaboration by providing an online community for sharing information and collaborating. This may motivate participants to be active due to ease of access and the fact that increased activity may increase participants' social capital. The mutual development process in the online communities in the studies can be characterized by the participants entering the community with the intention of developing a software product or learning resource further, and they may end their collaboration when their goal has been achieved. This has similarities to the notion of Communities of Interest (CoIs) suggested by Fischer (2009) to distinguish this form of community from a community of practice (Lave & Wenger, 1991). In addition, an implication of the mutual development process being mediated by an online community is that it is transparent. All prior interactions and collaborations are available for everybody to see and evaluate in the community, as it is publicly available to those who are registered. As a result, this open nature of the community enables all participants to take part simultaneously in different mutual development processes occurring in the discussion threads. This aligns with the notion of CoIs, in which the participants do not need a shared understanding of the

task or goal at hand (Fischer, 2009). The text-based interactions in online communities are of a “permanent character” due to being stored in the community’s archive and organized in different discussion threads. One consequence of this is that contributions made by different participants can build on each other, which may facilitate collaborative knowledge creation. This has similarities to the collaborative knowledge creation metaphor (Hakkarainen & Paavola, 2005). The different discussion threads and their mutual development processes are started, stopped and restarted based on the needs of the community. A drawback of the permanent character of text-based interactions is that it may take time to get feedback from peers because of the large number of people participating and the large volume of information. A limitation of online mediation in a distributed setting is that it may weaken the socialization process, which is a central aspect of the sociocultural perspective. Exploring the use of the computer as a cultural tool and its connection to socialization processes through digital tools is an emerging area of research.

6.5.2 Implications for the design of online communities

In this section, some suggestions based on the implications of the research in terms of better designs for online communities based on the research presented in this dissertation are proposed:

- Use an online community as a platform for mediating distributed collaboration organized around products or learning resources, emphasizing interaction between different participants.
- Enable a software product or learning resource to continually evolve by enabling them to be active co-creators in all phases of the mutual development process. One suggestion for stimulating this is to structure discussion threads in online communities with tags. Participants should be required to tag a discussion thread in each post, as in the online community in Study 3.
- Allow for power distribution between the participants to kick in first during the final decisions with regards to what ideas to pursue. The asymmetrical relationship between participants in the mutual development processes serves as a structuring mechanism and (arguably) a quality assurance of the results. For example, in Study 2, this could imply giving more articulated responsibility and power to course organizers with regards to creating tasks suitable for both less experienced and more experienced users.
- Design the community in such a manner that it enables end-users to drive the mutual development process forward. In Study 1, the end-users who are active contributors do

this because they receive incentives from the company for their activity. Or, in Study 3, the end-users who are dedicated and frequently contribute with sharing ideas and solutions are sometimes promoted to “champions” of the community and can gain part-time paid employment in the company.

- The online community should be designed with an infrastructure that can handle both small group collaboration and mass collaboration.
- The community should have mechanisms for facilitating both short-term and long-term mutual development processes. The community must be designed to enable mutual development and sustain it through defined responsibilities; such as a designated individual with whom to follow up on discussion threads that have been passive for a time. One possible design idea can be drawn from Study 3: using “champions” to follow up on passive discussion threads, spark discussions in dormant groups and trigger communication between end-users and professional developers.
- Allow for ideas generated by end-users to take different directions in the discussion threads, some with the ultimate goal of ending up as implemented features in general products or learning resources. Some ideas end as local adaptations made by or for specific customers, as seen in Study 1. Other ideas are developed further locally in interactions and collaborations between different end-users, as shown in Study 3.

7. Conclusions, Limitations and Directions for Further Research

This dissertation reveals how digitalization of life through increased use of online communities, creates new forms of collaboration and social interaction defined as mutual development. There is a changed focus from end-users as inactive consumers to active content creators in mutual development of a shared artifact. This emphasizes the empirical contribution with this dissertation, defining mutual development as a new form of interaction and collaboration where different participants (for example end-users, champions and professional developers) co-create in further development of a software product (Articles 1 and 3) and learning resource (Article 2). When the research questions for this dissertation first were formulated, focus was on end-users because I was interested in understanding how they participated in artifact co-creation processes. However, when collecting the empirical data for Article 1, I became aware that end-users went beyond “just” participating in the software product development processes. The participants demanded to be involved in almost all parts of the mutual development process, and wanted to be co-creators of content. The findings in

this dissertation reveals the dynamics of how participants with different backgrounds and domain expertise interact and collaborate in diverse constellations of collaboration with the common goal of co-creating a shared artifact in further development of a software product (Studies 1 and 3) or learning resource (Study 2) in online communities. This dissertation aimed to understand the interactions and collaborations in the real world of a plethora of interactions and turn-takings in online communities as well as their implications for concrete activities. If end-users are empowered to become active contributors in the mutual development processes mediated by online communities, companies could benefit from this by encouraging engaged end-users to forward improvement requests to the company. Thus, end-users would drive the development process forward. On one hand, the company would benefit because the end-users work for them for free, and they would have access to end-users' valuable knowledge about their own product, including ideas for the product's further development. On the other hand, end-users received the requested development without having to pay for it. Furthermore, the analysis of the mutual development process revealed that champions are a new type of user role that mediates interaction and collaboration between end-users and professional developers. Mutual development emphasizes the interaction and collaboration between all the different participants in online communities and how they together co-create shared artifacts, such as further developing software products or learning resources. However, it should be emphasized that the premise is active participants, and as seen in the empirical data, the online communities are situated in cultures of participation (Fischer, 2010) implicating active participants. Mutual development is characterized by a spirit of active and engaged participants who interact and collaborate through co-creating shared artifacts.

7.1 Reviewing the research questions

The main research question guiding the research for this dissertation is the following: What characterizes the online collaborative processes in artifact co-creation where different participants interact and collaborate in further development of a software product or learning resource mediated by an online community? This research question was addressed in section 6.1, where the characteristics of mutual development reported in the three articles are elaborated, identified and defined. The research question was answered by connecting the empirical findings in the articles (and that were obtained in the studies). The findings are compared and synthesized according to common denominators that defined mutual development as an empirical and theoretical contribution. Mutual development is

characterized by interaction and collaboration among the participants involved in co-creating a shared artifact, mediated by an online community. The nuanced characteristics of mutual development are presented in Table 5. This table showed the empirical variations of the concept as derived from the studies presented in the articles and theoretical inspired concepts. Mutual development can occur both in small group (Article 1) and mass collaboration (Articles 2 and 3) contexts. It also can occur in both informal learning settings at work (Articles 1 and 3) and in informal educational settings (Article 2). Depending on the context, different processes emerge in mutual development of a shared artifact by the involved participants. A model of mutual development that emerged from the findings of this dissertation was created, described and discussed in section 6.1 (see Figure 6).

Sub-research question 1: *What are the implications of mutual development for interaction and collaboration in online communities?* This sub-research question is empirically motivated and is answered in section 6.2, in which two empirical contributions and implications of the mutual development processes are elaborated: the trajectory of idea implementation and champions as a new user role. The trajectory of idea implementation fine grains the collaborative process of mutual development as it “travels” between different participants, from the idea as proposed by end-users to its potential inclusion (in some instances) in the general product that is made available to all end-users. Champions represent a new hybrid user role with dual responsibilities in the community: part-time employees of the company and end-users who volunteer their expertise to the company during their spare time. Champions represent a new form of work in the digital age. They are end-users who are employed to help with product adaptation and other problem-solving tasks as well as to mediate between end-users and professional developers in different online communities. This sub-research question was also addressed in section 6.5.1, which discussed the implications of mutual development being computer-mediated and in an online community.

Sub-research question 2: *What characteristics of mutual development can be derived from a theoretical framework?* This research question is theoretically motivated, and it was answered in two rounds. First, it is partly answered in section 6.1. As shown in Table 5, mutual development is defined by both empirical and theoretical characteristics. The theoretical characteristics were derived from the conceptual framework described in Chapter 3 and the literature review in Chapter 2. The theoretical concepts were tested on the empirical material in the studies, which led to the set of empirical characteristics shown in Table 5. The left-hand column in Table 5 presents the theoretically inspired concepts, and the other

columns present empirically inspired concepts. The theoretical framework was used for analyzing the empirical material. Second, this research question was answered in section 6.3, where two theoretical contributions became apparent in processes of mutual development: 1) the computer artifact as a mediating artifact and 2) the computer artifact as a continually evolving artifact. Computer artifacts are discussed in section 6.3.1, reflecting on the material sides in mediation, for example mediation through online communities. The concept of a product as “ever-changing” and continually evolving artifact depends on the constant feedback from end-users and champions.

Sub-research question 3: *What methods are appropriate for collecting and analyzing empirical data on mutual development in small group collaboration and in mass collaboration?* This methodologically motivated question is answered in section 6.4. The methodological contribution of this dissertation adds to the research field of integrative mixed methods. This contribution entails a hybrid strategy and a methodological bricolage. In Article 3, two methods, SNA and IA, were integrated to analyze the empirical data. SNA was used in integration with IA to zoom in on the IA data, which yielded a rich picture of information. SNA is a useful method for analyzing large sets of data, and it is used in two ways in this dissertation: (a) to select criteria for the empirical data examined and (b) to calculate centrality measurements that provide information about the social relations in the network and online community, such as identifying the most active and powerful participants in terms of communication choices (selection power) and the control of information (control power).

7.2 Directions for further research

This dissertation is an exploratory study where the purpose was to develop a new theoretical framework and conduct a methodological innovation. By creating a methodological bricolage it implies that the focus has been on looking for opportunities and possibilities for how to do it (e.g., rather than being concerned with whether it is necessary) and test it out in empirical contexts. This focus has been at the expense of spending time and space elaborating the critical perspectives. This is an area for further research. Further research complementing this dissertation would conduct additional empirical studies to test the new methodological framework in other contexts. Another direction for further research is to conduct further studies that apply the integrative mixed methods approach, integrating SNA and IA, in order to compare, contrast and extend the findings reported in Article 3. An interesting area for further research would be to interview representative champions and professional developers

about their work to confirm or refute the assumptions about their activities as reflected by their public statements in the online community's discussion threads. In addition, managers were not included in the sample because they did not use the online community. However, in future research, it would be interesting to collect empirical data with the aim of gaining insights into managers' ideas about the changes proposed to a computer artifact by end-users or champions. Insights could also be gained regarding the assumptions and consequences of the filtering processes used to decide which ideas and requests from customers to follow up and develop. Another interesting area for further research would be to follow a champion over time in a mutual development process to gather information about their social practices and how the transition from end-user to champion occurs.

References

- Akoumianakis, D. (2014). Ambient affiliates in virtual cross-organizational tourism alliances: A case study of collaborative new product development. *Computers in Human Behavior, 30*, 773–786.
- Andersen, R. (2008). *Customer-initiated product development: A case study of adaptation and co-configuration* (Master's thesis). University of Oslo, Norway.
- Andersen, R. (2012a). Crowdsourcing and participatory media: New ways of working together through online collaborations and the use of social media. Paper presented at the *Conference of EARLI SIG17: Qualitative and Quantitative Approaches to Learning and Instruction*, Deventer, Netherlands.
- Andersen, R. (2012b). Social media in product development processes: The role of emotional qualifiers in text-based interactions. In A. Følstad, A. Ståhlbröst, E. Esbjörn & J. Svensson (Eds.), *Proceedings of innovation through social media: ISM 2012*, (pp. 104–118). Oslo: Akademika forlag.
- Andersen, R. (2012c). Artifact co-production in cultures of participation: The case of Get Satisfaction. Paper presented at *Collaborative Learning as Design Activity Workshop at NordiCHI*, Copenhagen, Denmark.
- Andersen R., & Mørch, A. I. (2009). Mutual development: A case study in customer-initiated software product development. In V. Pipek, M. B. Rosson, B de Ruyter, & V. Wulf (Eds.), *End-user development: Proceedings of the 2nd international symposium on end-user development*, (pp. 31–49). Siegen, Germany: Springer
- Andersen, R. & Mørch, A. I. (2011). Researching mediation in mutual development of software products. Paper presented at the *Conference of IS-EUD 2011; Third International Symposium on End-User Development*: Brindisi, Italy.
- Andersen, R. & Mørch, A. I. (2013a). Problem-based learning and mutual development in software product development. In E. Christiansen, L. Kuure, A. I. Mørch & B. Lindstrøm (Eds.), *Problem-based learning for the 21st century: New practices and learning environments* (pp. 307–335). Denmark: Aalborg Universitetsforlag.
- Andersen, R. & Mørch, A. I. (2013b). Get Satisfaction: Customer engagement in collaborative software development. In Y. Dittrich, M. Burnett, A. Mørch & D. Redmiles (Eds.), *International symposium on end-user development*, (pp. 235–240). Berlin: Springer.
- Andersen, R. & Mørch, A. I. (2016a). Mutual development in mass collaboration: Identifying interaction patterns in customer-initiated software product development. *Computers in Human Behavior, 65*, 77–91.
- Andersen, R. & Mørch, A. I. (2016b). Mass collaboration in software product development between developers and users: Champion as emergent role. Paper presented at *Proceedings of Fourth International Workshop on Cultures of Participation in the Digital Age*, 14–20. Gothenburg, Sweden.

- Andersen, R. & Ponti, M. (2014). Participatory pedagogy in an open educational course: Challenges and opportunities. *Distance Education*, 35(2), 234–249.
- Arnseth, H. C. (2004). *Discourse and artefacts in learning to argue. Analysing the practical management of computer supported collaborative learning* (Doctoral dissertation). University of Oslo, Norway.
- Arnseth, H. C. & Ludvigsen, S. (2006). Approaching institutional contexts: Systemic versus dialogic research in CSCL. *International Journal of Computer-Supported Collaborative Learning*, 1(2), 167-185.
- Babbie, E. R. (2014). *The basics of social research*. 6e. Belmont, CA: Thomson Wadsworth.
- Baggaley, J. (2013). MOOC rampant. *Distance Education*, 34(3), 368–378.
- Baird, C. H. & Parasnis, G. (2011). From social media to social customer relationship management. *Strategy & Leadership*, 39(5), 30–37.
- Bateson, G. (1972). *Steps to an ecology of mind: Collected essays in anthropology, psychiatry, evolution, and epistemology*. New York: Cambridge University Press.
- Baturay, M. H. (2015). An overview of the world of MOOCs. *Procedia-Social and Behavioral Sciences*, 174, 427-433.
- Bazeley, P. (2017). *Integrating analysis in mixed methods research*. London: Sage Publications.
- Bergman, M. (2008). *Advances in mixed methods research. Theories and applications*. Los Angeles: Sage Publications.
- Bergsund, M. B. (2017). *Sosiale strukturers innvirkning på kunnskapsdeling i små grupper. Case melkekubønder på Facebook* (Master's thesis). University of Oslo, Norway.
- Boellstorff, T., Nardi, B., Pearce, C. & Taylor, T. L. (2012). *Ethnography and virtual worlds: A handbook of method*. New Jersey: Princeton University Press.
- Borgatti, S. P., Everett, M. G. & Freeman, L. C. (2002). *Ucinet 6 for Windows*. Harvard: Analytic Technologies.
- Borgatti, S. B., Everett, M. G. & Johnson, J. C. (2013). *Analyzing social networks*. London: Sage Publications.
- Brahimi, T. & Sarirete, A. (2015). Learning outside the classroom through MOOCs. *Computers in Human Behavior*, 51, 604–609.
- Breiger, R. L. (1974). The duality of persons and groups. *Social Forces*, 53(2), 181–190.
- Cole, M. & Wertsch, J. V. (1996). Beyond the individual-social antinomy in discussions of Piaget and Vygotsky. *Human Development*, 39, 250–256.
- Conole, G. (2009). The role of mediating artefacts in learning design. In *Handbook of research on learning design and learning objects: issues, applications, and technologies* (pp. 188–208). IGI Global.

- Costabile, M. F., Mussio, P., Parasiliti-Provenza, L. & Piccinno, A. (2008). End-users as unwitting software developers, *Proceedings of the 4th international workshop on end-user software engineering* (pp. 6–10). New York.
- Cress, U. (2013). Mass collaboration and learning. In R. Luckin, S. Puntambekar, P. Goodyear, B. Grabowski, J. Underwood & N. Winters (Eds.), *Handbook of design in educational technology* (pp. 416–424). New York: Routledge.
- Cress, U. & Fischer, G. (2017). Mass collaboration with social software in TEL. In E. Duval, M. Sharples & R Sutherland. (Eds.) *Technology-enhanced learning* (pp. 59–67). New York: Springer International Publishing.
- Cress, U. Jeong, H. & Moskaliuk, J. (2016). Mass collaboration as an emerging paradigm for education? Theories, cases, and research methods. In U Cress, J. Moskaliuk & H.Jeong (Eds.) *Mass collaboration and education* (pp. 3–27). New York: Springer International Publishing.
- Creswell, J., Clark, V. L. P., Gutmann, M. & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 209–240). Thousand Oaks, CA: Sage Publications.
- Dabbagh, N. & Kitsantas, A. (2012). Personal learning environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education*, 15(1), 3–8.
- Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F. Goldman, Hall, R. & Sherin, B. L. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *Journal of the Learning Sciences*, 19(1), 3–53.
- Dillenbourg, P. (1999). What do you mean by collaborative learning? In P. Dillenbourg (Eds.) *Collaborative-learning: Cognitive and computational approaches*. (pp. 1–19). Oxford: Elsevier.
- Dittrich, Y. & Vancouleur, S. (2008). Practices around customization of standard systems. *Proceedings of the 2008 International Workshop on Co-operation and Human Aspects of Software Engineering* (pp. 37–40). ACM: Germany.
- Draxler, S. & Stevens, G. (2011). Supporting the collaborative appropriation of an open software ecosystem. *Computer Supported Cooperative Work (CSCW)*, 20(4-5), 403–448.
- Driscoll, D. L., Appiah-Yeboah, A., Salib, P. & Rupert, D. J. (2007). Merging qualitative and quantitative data in mixed methods research: How to and why not, *Ecological and Environment Anthropology* 3(1), 19–28.
- Dysthe, O. (2001). Sosiokulturelle teoriperspektiv på kunnskap og læring. In O. Dysthe (Ed.), *Dialog, samspel og læring* (pp. 33–72). Oslo: Abstrakt Forlag.
- Eisenhart, M. (2009). Generalization from qualitative inquiry. In K. Ercikan & W.-M. Roth (Eds.), *Generalizing from educational research* (pp. 51–66). London: Routledge.
- El-Nasr, M. S. & Smith, B. K. (2006). Learning through game modding. *Computers in Entertainment (CIE)*, 4(1), 7. ACM: New York.

- Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit.
- Engeström, Y. (1999). Activity theory and individual and social transformation. *Perspectives on activity theory*, 19(38).
- Engeström, Y. (2004). New forms of learning in co-configuration work. *The Journal of Workplace Learning*, 16, 11–21.
- Engeström, Y. (2009). The future of activity theory: A rough draft. In A. Sannino, H. Daniels & K. D. Gutierrez (Eds.), *Learning and expanding with activity theory* (pp. 303–328). Cambridge: Cambridge University Press.
- European Commission. (2016). Europe in a changing world: Inclusive, innovative and reflective societies. Downloaded from <http://ec.europa.eu/programmes/horizon2020/en/h2020-section/europe-changing-world-inclusive-innovative-and-reflective-societies>
- Fischer, G. (2001). Communities of interest: Learning through the interaction of multiple knowledge systems. *Proceedings of the 24th. IRIS Conference*, (pp. 1–14). Ulvik, Norway.
- Fischer, G. & Ostwald, J. (2002). Seeding, evolutionary growth, and reseeded: Enriching participatory design with informed participation. *Proceedings of the Participatory Design Conference, PDC Vol. 2*, (pp. 135–143). Malmö University, Sweden.
- Fischer, G. (2003). Meta-design: Beyond user-centered and participatory design. In *Proceedings of HCI International 2003*. Crete, Greece (June), C. Stephanidis (Ed.), Vol. 4, (pp. 88-92) New Jersey: Lawrence Erlbaum Associates.
- Fischer, G. (2009). End-user development and meta-design: Foundations for cultures of participation. *Proceedings Second International Symposium on End-user Development* (pp. 3–14). Springer-Verlag: Berlin, Heidelberg.
- Fischer, G. (2010). Extending boundaries with meta-design and cultures of participation. *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries* (pp. 168–177). ACM: Reykjavik.
- Fischer, G. (2011). Understanding, fostering, and supporting cultures of participation. *Interactions*, 18(3), 42–53.
- Fischer, G. (2013). End-user development: From creating technologies to transforming cultures. *International Symposium on End-user Development* (pp. 217–222). Berlin; Heidelberg: Springer.
- Fischer, G. (2014). Beyond hype and underestimation: Identifying research challenges for the future of MOOCs. *Distance Education*, 35(2), 149–158.
- Formanek, M., Wenger, M. C., Buxner, S. R., Impey, C. D. & Sonam, T. (2017). Insights about large-scale online peer assessment from an analysis of an astronomy MOOC. *Computers & Education*, 113, 243-262.

- Freeman, L. C. (1979). Centrality in networks: Conceptual clarification. *Social Networks*, 1(3), 215–239.
- Furberg, A., Kluge, A. & Ludvigsen, S. (2013). Student sense-making with science diagrams in a computer-based setting. *International Journal of Computer-Supported Collaborative Learning*, 8(1), 41–64.
- García-Peñalvo, F. J., Fidalgo-Blanco, Á. & Sein-Echaluce, M. L. (2017). An adaptive hybrid MOOC model: Disrupting the MOOC concept in higher education. *Telematics and Informatics*, 35(4), 1018-1030.
- Gee, J. P. (2005). Affinity spaces: From the age of mythologies to today's schools. Downloaded from <http://www.jamespaulgee.com/publications>
- Giere, R. N. (2004). How models are used to represent reality. *Philosophy of Science*, 71(5), 742–752.
- Glaser, B. G. (1965). The constant comparative method of qualitative analysis. *Social Problems*, 12(4), 436–445.
- Glaser, B. G., Strauss, A. L. & Strutzel, E. (1968). The discovery of grounded theory: Strategies for qualitative research. *Nursing Research*, 17(4), 364.
- Greene, J. C., Caracelli, V. J. & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, 11(3), 255–274.
- Grohn, J. L. (2017). *Exploring co-creation experience and value in the video game industry: How gamers create value through a rule changing online game that has no rules* (Bachelor's thesis) University of Twente, Netherlands.
- Hanneman, R. A. & Riddle, M. (2005). *Introduction to social network methods*. Riverside, CA: University of California, Riverside (published in digital form at <http://faculty.ucr.edu/~hanneman/>)
- Hammersley, M. (1983). *Ethnography: Principles in practice*. New York: Tavistock Publications.
- Hetland, P. & Mørch, A. I. (2016). Ethnography for investigating the internet. *Seminar.net: Media, Technology and Lifelong Learning*, 12(1), 1–14.
- Hetland, P. (2017). Rethinking the social contract between science and society: Steps to an ecology of science communication. *Series of dissertations submitted to the Faculty of Education, University of Oslo*.
- Hine, C. (2005). *Virtual methods: Issues in social research on the internet*. Berg: Oxford International Publishers Ltd.
- Hine, C. (2008). Virtual ethnography: Modes, varieties, affordances. In N. Fielding, R. M. Lee & G. Blank (Eds.). *The Sage handbook of online research methods*. London: SAGE Publications.

- Hone, K. S. & El Said, G. R. (2016). Exploring the factors affecting MOOC retention: A survey study. *Computers & Education*, 98, 157–168.
- Ihantola, E. M. & Kihn, L. A. (2011). Threats to validity and reliability in mixed methods accounting research. *Qualitative Research in Accounting & Management*, 8(1), 39–58.
- Jeong, H., Cress, U., Moskaliuk, J. & Kimmerle, J. (2017). Joint interactions in large online knowledge communities: The A3C framework. *International Journal of Computer-Supported Collaborative Learning*, 12(2), 133–151.
- Jeong, H. & Hmelo-Silver, C. E. (2010). An overview of CSCL methodologies. *Proceedings of the 9th International Conference of the Learning Sciences* (Vol. 1), (pp. 921–928). International Society of the Learning Sciences. Chicago, Illinois.
- Jeppesen, L. B. (2004). *Profiting from innovative user communities: How firms organize the production of user modifications in the computer games industry* Working Paper WP-04, Copenhagen Business School, Department of Industrial Economics and Strategy, Copenhagen, Denmark.
- Jordan, B. & Henderson, A. (1995). Interaction analysis: Foundation and practice. *The Journal of the Learning Sciences*, 4, 39–103.
- Kahler, H. (2001). *Supporting collaborative tailoring* (Doctoral dissertation). Roskilde University, Denmark.
- Karnouskos, S. (2017). Massive open online courses (MOOCs) as an enabler for competent employees and innovation in industry. *Computers in Industry*, 91, 1–10.
- King, N. (1994). Template analysis. In G. Symon & C. Cassell, C. (Eds.), *Qualitative methods and analysis in organizational research: A practical guide* (pp. 118–134). London: Sage.
- Knox, J. (2014) Digital culture clash: “Massive” education in the *E-learning and Digital Cultures* MOOC, *Distance Education*, 35(2), 164-177.
- Kozinets, R.V. (2010). *Netnography: Doing ethnographic research online*. London: Sage Publications.
- Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Leifeld, P. (2018, November 03) Discourse Network Analyzer. Downloaded from <https://www.philipleifeld.com/software/software.html>
- Leifeld, P. (2010). *Discourse Network Analyzer (DNA) manual*. Downloaded from <http://www.philipleifeld.de/discourse-network-analyzer-dna/manual>
- Lieberman, H., Paternò, F., Klann, M. & Wulf, V. (2006). End-user development: An emerging paradigm. In H. Lieberman, F. Paternò & V. Wulf (Eds.), *End-user development* (Human-computer interaction series, vol. 9), (pp. 1–7). Netherlands: Springer.

- Lipponen, L., Hakkarainen, K. & Paavola, S. (2004). Practices and orientations of CSCL. In J.- W. Strijbos, P. Kirschner & R. Martens (Eds.), *What we know about CSCL, And implementing it in higher education* (pp. 31-50). Dordrecht, Netherlands: Kluwer Academic Publishers.
- Littlejohn, A., Hood, N., Milligan, C. & Mustain, P. (2016). Learning in MOOCs: Motivations and self-regulated learning in MOOCs. *The Internet and Higher Education*, 29, 40–48.
- Liu, C. C., Chen, Y. C. & Tai, S. J. D. (2017). A social network analysis on elementary student engagement in the networked creation community. *Computers & Education*, 115, 114–125.
- Ludvigsen, S. & Mørch, A. (2003). Categorisation in knowledge building. In *Designing for change in networked learning environments. Proceedings of the International Conference on Computer Support for Collaborative Learning (CSCL)*, B. Wasson, S.R. Ludvigsen & U. Hoppe (Eds.), (vol. 2), (pp. 67–76). Dordrecht: Kluwer Academic Publishers.
- Ludvigsen, S., Law, N., Rose, C. P. & Stahl, G. (2017). Frameworks for mass collaboration, adaptable scripts, complex systems theory, and collaborative writing. *International Journal of Computer-Supported Collaborative Learning*, 12(2), 127–131.
- Mansour, O., Abusalah, M. & Askenäs, L. (2011). Wiki-based community collaboration in organizations. *Proceedings of the 5th International Conference on Communities and Technologies* (pp. 79–87). ACM: New York.
- Martínez, A., Dimitriadis, Y., Gómez-Sánchez, E., Rubia-Avi, B., Jorrín-Abellán, I. & Marcos, J. A. (2006). Studying participation networks in collaboration using mixed methods. *International Journal of Computer-Supported Collaborative Learning*, 1(3), 383–408.
- McLoughlin, C. & Lee, M. J. (2010). Personalised and self-regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. *Australasian Journal of Educational Technology*, 26(1), 28-43.
- Mifsud, L. (2012). *Learning with mobile technologies: Perspectives on mediated actions in the classroom*. (Doctoral dissertation), University of Oslo: Faculty of Educational sciences.
- Moen, A., Mørch, A. I. & Paavola, S. (2012). *Collaborative knowledge creation: Introduction* in A. Moen, A. I., Mørch & S. Paavola (Eds.), (Vol. 7). Rotterdam, The Netherlands: Sense Publishers.
- Monteiro, E., Pollock, N., Hanseth, O. & Williams, R. (2013). From artefacts to infrastructures. *Computer Supported Cooperative Work (CSCW)*, 22(4–6), 575–607.
- Mørch, A. (1997a). Three levels of end-user tailoring: Customization, integration, and extension. In M. Kyng and L. Mathiassen (Eds), *Computers and Design in Context*. Cambridge, MA: The MIT Press, 51–76.

- Mørch, A.I. (1997b). *Method and tools for tailoring of object-oriented applications: An evolving artifacts approach*. (Doctoral dissertation). Department of Informatics, University of Oslo, Norway.
- Mørch, A. & Andersen, R. (2010). Mutual development: The software engineering context of end-user development. *Journal of Organizational and End-user Computing*, 22(2), 36–57.
- Mørch, A. I., Hansen Åsand, H. R. & Ludvigsen, S. R. (2007). The organization of end-user development in an accounting company. In S. Clarke, (Ed.), *End-user computing challenges and technologies: Emerging tools and applications*, (pp. 102-123). London: Information Science Reference.
- Mørch, A. I., Caruso, V. & Hartley, M. D. (2017). End-user development and learning in Second Life: The evolving artifacts framework with application. In F.Paterno & V. Wulf (Eds.), *New perspectives in end-user development* (pp. 333–358). Berlin: Springer.
- Mørch, A. I., Caruso V., Hartley M. D. & Ludlow, B.L. (2018). Creating contexts for collaborative learning in a 3D virtual world for distance education. In Y. Qian (Ed.), *Integrating multi-user virtual environments in modern classrooms* (pp. 137-164) Hershey, PA: IGI Global.
- National Committee for Research Ethics in the Social Sciences and the Humanities. (2006). Guidelines for research ethics in the social sciences, law and the humanities. Retrieved from <https://www.etikkom.no/forskningsetiske-retningslinjer/Generelle-forskningsetiske-retningslinjer/>
- Ostwald, J.L. (1996). *Knowledge construction in software development. The Evolving artifact approach*. (Doctoral Dissertation). Boulder, CO: University of Colorado at Boulder.
- Paavola, S. & Hakkarainen, K. (2005). The knowledge creation metaphor: An emergent epistemological approach to learning. *Science & Education*, 14(6), 535–557.
- Paavola, S. & K. Hakkarainen. (2014). Trialogical approach for knowledge creation. In S. C. Tan, H. J. So & J. Yeo (Eds.), *Knowledge creation in education* (pp. 53–73). Singapore: Springer.
- Packer, M. J. & Goicoechea, J. (2000). Sociocultural and constructivist theories of learning: Ontology, not just epistemology. *Educational Psychologist*, 35(4), 227–241.
- Parvatiyar, A. & Sheth, J. N. (2001). Customer relationship management: Emerging practice, process, and discipline. *Journal of Economic & Social Research*, 3(2), 1-34.
- Payne, A. & Frow, P. (2005). A strategic framework for customer relationship management. *Journal of Marketing*, (69), 167–176.
- Pongolini, M., Lundin, J. & Svensson, L. (2011). Global online meetings in virtual teams: From media choice to interaction negotiation. *Proceedings of the 5th International Conference on Communities and Technologies* (pp. 108–117). New York: ACM.
- Preece, J. (2001). Sociability and usability: Twenty years of chatting online. *Behavior and Information Technology Journal*, 20(5), 347–356.

- Reinhold, O. & Rainer, A. (2012). Social customer relationship management: State of the art and learning from current projects. In *BLED 2012 Proceedings*, (pp. 155–169), Slovenia.
- Resta, P. & Laferrière, T. (2007). Technology in support of collaborative learning. *Educational Psychology Review*, 19(1), 65–83.
- Rheingold, H. (1993). *The virtual community: Finding connection in a computerized world*. Boston, USA: Addison-Wesley Longman Publishing.
- Roque, R., Rusk, N. & Resnick, M. (2016). Supporting diverse and creative collaboration in the Scratch online community. In U. Cress, J. Moskaliuk & H. Jeong (Eds) *Mass collaboration and education* (pp. 241–256). Computer-Supported Collaborative Learning Series, vol. 16. London: Springer International Publishing.
- Rosé, C. P. & Ferschke, O. (2016). Technology support for discussion based learning: From computer supported collaborative learning to the future of massive open online courses. *International Journal of Artificial Intelligence in Education*, 26(2), 660–678.
- Säljö, R. (2001). *Läring i praksis. Et sosiokulturelt perspektiv*. Oslo: JW Cappelens forlag.
- Säljö, R. (2006). *Läring og kulturelle redskaper. Om læreprosesser og den kollektive hukommelsen*. Oslo: JW Cappelens Forlag.
- Scott, J. (2000). *Social network analysis: A handbook*. London: Sage Publications.
- Scott, J. (2012). *Social network analysis*. London: Sage Publications.
- Silverman, D. (2005). *Doing qualitative research*. London: Sage Publications.
- Silverman, D. (2006). *Interpreting qualitative data*. London: Sage Publications.
- Singh, A. B. & Mørch, A. I. (2018). An analysis of participants experiences from the first international MOOC offered at the University of Oslo. *Nordic Journal of Digital Literacy*. 13(01), 40-64.
- Sotamaa, O. (2010). When the game is not enough: Motivations and practices among computer game modding culture. *Games and Culture*, 5(3), 239–255.
- Stahl, G. (2006). *Group cognition: Computer support for building collaborative knowledge*. Cambridge, MA: MIT Press.
- Stahl, G. (2011). *Essays in computer-supported collaborative learning*. Philadelphia, PA: Gerry Stahl at Lulu.
- Stahl, G. (2013). Interaction analysis of a biology chat. In D. Suthers, K. Lund, C. P. Rosé & N. Law (Eds.), *Productive multivocality in the analysis of group interactions*. New York, NY: Springer.
- Stahl, G., Law, N., Cress, U. & Ludvigsen, S. (2014). Analyzing roles of individuals in small-group collaboration processes. *International Journal of Computer-Supported Collaborative Learning*, 9(4), 365–370.

- Stahl, G., Koschmann, T. D. & Suthers, D. D. (2006). CSCL: An historical perspective. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 409–426). Cambridge, UK: University Press.
- Søreide, G. E. (2007). *Narrative construction of teacher identity*. Dissertation submitted at the University of Bergen.
- Tapscott, D. & Williams, A. D. (2008). *Wikinomics: How mass collaboration changes everything*. London: Atlantic Group.
- Tashakkori, A. & Teddlie, C. (Eds.). (2010). *Handbook of mixed methods in social and behavioral research*. London: Sage Publications.
- Victor, B. & Boynton, A. C. (1998). *Invented here: Maximizing your organization's internal growth and profitability*. Boston: Harvard Business School Press.
- Von Hippel, E. (2005). *Democratizing innovation*. London: MIT press.
- Von Hippel, E. & Krogh, G. V. (2003). Open source software and the “private-collective” innovation model: Issues for organization science. *Organization Science*, 14(2), 209–223.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- Walji, S., Deacon, A., Small, J. & Czerniewicz, L. (2016). Learning through engagement: 39 MOOCs as an emergent form of provision. *Distance Education*, 37(2), 208–223.
- Widerberg, K. (2001). *Historien om et kvalitativt forskningsprosjekt*. Oslo: Universitetsforlaget.
- Winer, R. S. (2001). A framework for customer relationship management, *California Management Review*, 43(4), 89–105.
- We are social. (2018, 4 November). Global digital report 2018. Downloaded from: <https://wearesocial.com/blog/2018/01/global-digital-report-2018>
- Wertsch, J. V. (1991). *Voices of the mind: A sociocultural approach to mediated action*. Cambridge: MA: Harvard University Press.
- Wertsch, J. V. & Rupert, L. J. (1993). The authority of cultural tools in a sociocultural approach to mediated agency. *Cognition and Instruction*, 11(3-4), 227–239.
- Yin, R. K. (2014). *Case study research: Design and methods*. London: Sage Publications.
- Åsand, H.-R. & Mørch, A.I. (2006). Super users and local developers: The organization of end-user development in an accounting company. *Journal of Organizational and End-user Computing*, 18(4), 1–21.

Appendix 1: Passive consent posted in the online community (Article 3)

Hello!

My name is Renate Andersen and I am a researcher from University of Oslo in Norway. I am researching on how social media as a technology in an online environment such as Get Satisfaction is being used for communication between end users and professionals. I am reading and studying some of the discussion threads here at Get Satisfaction, this being one of them. If anyone wants to contact me or have anything to say I would be very happy to email with you.

My contact information is:

My name: Renate Andersen

Email: renate.andersen@intermedia.uio.no

My Webpage:

<http://www.uv.uio.no/intermedia/english/people/aca/renatej/index.html@intermedia.uio.no>

Yours Sincerely,

Renate Andersen.

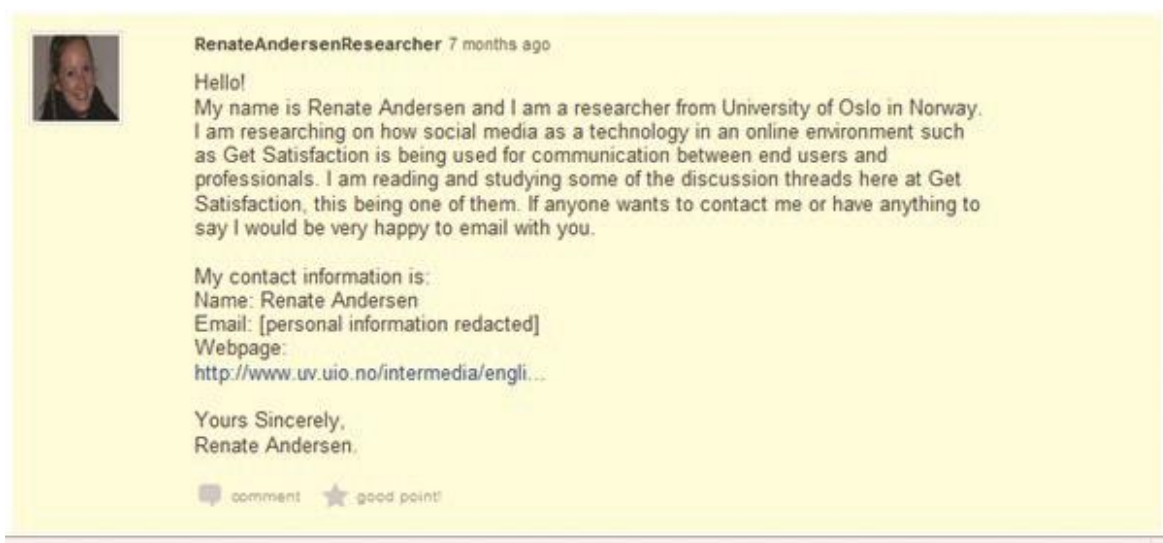


Figure 8: Screenshot from one discussion thread at the GS online community where the informed consent was posted.

Appendix 2: Author's declarations

Declarations describing the independent research contributions of the candidate

This declaration²⁵ states the contributions of the candidate with regard to the formulation and identification of the scientific problem, the conception and design of the research projects, the planning of the field research and method design, the collection of the empirical data, the analysis and interpretation of the data, and the involvement in the review of the literature as well as contributions to writing the first draft and revising it critically after feedback from the reviewers. In order to be consistent, I use the following categories to describe the different parts: (a) contributed to the work (0–33%), (b) made a substantial contribution (34–66%), and (c) did the majority of the work (67–100%). when describing the different parts.

Please see the following pages.

²⁵ The format of this author declaration was adapted by Damsa (2013) and an author declaration guide provided by Syddansk Universitet (2017). A) Syddansk Universitet, 2017. *Declaration of co-authorship (PhD thesis)*. Retrieved from <https://www.sdu.dk/-/media/files/forskning/phd/phd.../co-authorship.docx>; B) Damşa, C. (2013), Knowledge co-construction and object-oriented collaboration. A study of learning through collaborative construction of knowledge objects in higher education.

Article I

Andersen, R., & Mørch, A. I. (2009). Mutual development: A case study in customer-initiated software product development. In *International Symposium on End-User Development* (pp.31-49). Springer, Berlin, Heidelberg.

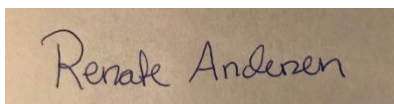
The independent contribution of the candidate

- I contributed to the formulation in the concept phase of the basic scientific problem.
- I did the majority of work in preparing data collection, creating the interview guide and collecting the necessary empirical data in a joint data collection process.
- I did the majority of work when transcribing, analyzing and selecting the empirical material.
- I contributed to the choice of theory employed in the article.
- I did the majority of work in writing the first version of the article.
- I contributed to writing the drafts and the final version of the article.

Contribution of the co-author

- He contributed to the formulation in the concept phase of the article.
- He contributed to selecting what empirical material to include in the article through collaborative data workshops.
- He contributed to the choice of theory employed in the article.
- He provided feedback on written versions of this article and contributed to sections of the manuscript.
- He contributed to proofreading versions of the manuscript, writing drafts and the final version of the article.
- He contributed by giving me access to the literature in the field of EUD.
- He submitted, kept contact with the journal and finalized the details of the publishing process.
- He presented an early version of the article at the Second International Symposium on End-User Development in Siegen (2009) where the article received an award for the "Best Paper."

1. October 2017



Signature of the candidate

1 October 2017



Signature of the co-author

Article II

Andersen, R., & Ponti, M. (2014). Participatory pedagogy in an open educational course: Challenges and opportunities. *Distance Education*, 35(2), 234-249.

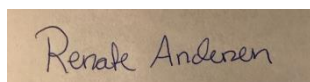
The independent contribution of the candidate

- I contributed to the formulation in the concept phase of the basic scientific problem.
- I made a substantial contribution to preparing the data collection (through virtual ethnography) and collecting the necessary empirical data in a joint data collection process.
- I contributed to coding the empirical data for more than one year using a technological tool.
- I contributed to transcribing and analyzing the empirical data.
- I made a substantial contribution to selecting the empirical material.
- I did the majority of work in choosing the theory employed in the article.
- I did the majority of work in writing the first version of the article, drafts and the final version of the article.
- I submitted, kept contact with the journal and finalized the details of the publishing process.

Contribution of the co-author

- She contributed to the formulation in the concept phase of the article.
- She provided and had access to the empirical data.
- She contributed input in selecting the empirical material to include in the article through collaborative data workshops.
- She contributed to coding the empirical data for more than one year using a technological tool.
- She contributed to transcribing and analyzing the data.
- She contributed by providing intellectual input and constructive feedback to improve the paper in several revisions of sections of the manuscript.
- She contributed to proofreading versions of the manuscript.

1 October 2017



Signature of the candidate

1 October 2017



Signature of the co-author

Article III

Andersen, R., & Mørch, A. I. (2016). Mutual development in mass collaboration: Identifying interaction patterns in customer-initiated software product development. *Computers in Human Behavior*, 65, 77-91.

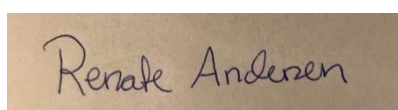
The independent contribution of the candidate

- I made a substantial contribution to the formulation in the concept phase of the basic scientific problem based on theoretical questions that required clarification.
- I made a substantial contribution in planning the field research and method design.
- I did the majority of work in preparing the data collection and collecting the empirical data.
- I did the majority of work in transcribing, analyzing and selecting the empirical material.
- I contributed to choosing the theory employed in the article.
- I did the majority of work in writing the first version of the article, drafts and the final version of the article.
- I made a major contribution to calculating and performing the social network analysis (SNA) using the technological tool Ucinet.
- I contributed to understanding the concepts of social network analysis.
- I presented an early version of the article at the Conference of EARLI SIG17 Qualitative and Quantitative Approaches to Learning and Instruction, where it was received the "Top 4 Best Papers" award.

Contribution of co-author

- He contributed to the formulation in the concept phase of the article.
- He contributed to planning the field research and method design.
- He contributed to selecting the empirical material to include in the article through collaborative data workshops.
- He contributed to choosing theory employed in the article.
- He provided feedback on written versions of this article and contributed to sections of the manuscript.
- He proofread versions of the manuscript.
- He made a major contribution to understanding the concepts connected to social network analysis.
- He submitted, kept in contact with the journal, and finalized the details of the publishing process.

1 October 2017



Signature of the candidate

1 October 2017



Signature of the co-author

PART II:
THE ARTICLES

Article I

Andersen, R. & Mørch, A. I. (2009). Mutual development: A case study in customer-initiated software product development. In *International Symposium on End-User Development* (pp. 31-49). Springer, Berlin, Heidelberg.

Mutual Development: A Case Study in Customer-Initiated Software Product Development

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Abstract. The paper is a case study of customer-initiated software product development. We have observed and participated in system development activities in a commercial software house (company) over a period of two years. The company produces project-planning tools for the oil and gas industry, and relies on interaction with customers for further development of its products. Our main research question is how customers and professional developers engage in mutual development mediated by shared software tools (products and support systems). We have used interviews with developers and customers as our main source of data, and identified the activities (from use to development) where customers have contributed to development. We analyze our findings in terms of co-configuration, meta-design and modding in order to name and compare the various stages of development (adaptation, generalization, improvement request, specialization, and tailoring).

Keywords: customer-initiated product development, software development, case study, empirical analysis, theoretical perspectives, mutual development.

1 Introduction

The goal of the research reported here is to identify areas where end-user development (EUD) and professional software development interact. We have observed and participated in development activities in a commercial software house (referred to as company in the remainder of the paper) over a period of two years. We propose a model of the activities, which we refer to as mutual development. The model consists of the 5 sub-processes, which connects EUD and professional development.

1.1 The Case

The company is engaged in commercial software development in the area of project planning and management and provides consultancy services in using its tools. At present, the company employs 25-30 people, but they intend to grow and is concurrently expanding their staff and searching for new markets. The main market has been the Nordic oil and gas industry. To expand into new markets, particularly building and construction, the company has started to modify and improve its knowledge management practices regarding customer relations. As researchers, we were invited by

the company to give advice for how to improve knowledge management practices with customers.

The company is known for their customer initiated product development approach, i.e. close interaction with customers to develop tailor-made products [1][31]. Customers are encouraged to report problems, innovative use, and local development to the company. This has been stimulated through long-term relationships (maintenance contracts) and user forums. Each year the company hosts a large showcase where customers are invited, and developers provide communication and information sharing tools for customer interaction. This started with the telephone, then supplemented by mail, later extending to a Helpdesk interface, then a Customer Relationship Management (CRM) system, and most recently a Web 2.0 prototype created by the research team [29].

Despite their small size, the company is recognized as a major player in the business of project planning tools. They have several hundred customers and they have long-term commitments with many of them. One of their recent products is an add-on to Microsoft Project.

Our main research question and objective is how there is mutual development between customers, professional developers mediated by software products and ICT support systems in the company we studied. By *mutual development* we mean that both professional developers and end users contribute to development as active participants in both design and use. We identify the range of end-user development activities (from use to design) taking place in the interaction between the company's developers and some of their customers.

We have identified five sub-processes (adaptation, generalization, improvement requests, specialization, and tailoring) by pinpointing what developers and customers are doing and where their activities meet and overlap. We base our analysis on interviews with developers, consultants, and customers, and on data from a video-recorded workshop. The findings are compared with previous research in EUD and analyzed in terms of co-configuration [7][8], meta-design [10][12] and modding [15][16]. The goal is to identify the interdependencies of EUD and professional development and to construct a model for their mutual development.

The rest of the paper is organized as follows. It starts with an overview of EUD. Next, we present a survey of research in the intersection of EUD and software development. Then we present three theoretical perspectives on EUD. We analyze our findings by comparing with the three perspectives. At the end open issues for further research is suggested.

2 End-User Development

End-user development is an umbrella term for research and development in end-user tools for application development. This originated with research that dealt with technological and organizational issues of an emerging field, such as end-user programming in spreadsheets and tailorable systems [22]. Most recently, web application development has introduced a new line of R&D that shares many similarities with EUD (e.g., mashups, Yahoo pipes). However, EUD was perhaps first established as a research field with its own agenda in the European EUD-Net project (2002-3), which

defines EUD as “a set of methods, activities, techniques, and tools that allow people who are non-professional software developers, at some point to create or modify a software artifact” [21]. The different approaches to EUD vary with respect to how they emphasize methods, activities, techniques, and tools, and whether they focus on creation or modification of software artifacts. Furthermore, what a software artifact means also varies among researchers. Software tools, source code, design diagrams, application units, and application development environments have been mentioned. As an example, end-user tailoring is about methods, activities, techniques, and tools for adaptation and further development of existing software applications based on direct activation of tailoring tools from the applications’ user interface [25] [39].

EUD is multidisciplinary and its rationale (the “*why*” of EUD) has multiple dimensions: human-computer interaction (HCI), software engineering, and organizational use. From a *human-computer interaction* perspective, EUD is about leveraging the deployment of easy-to-use ICT and turning them into easy-to-further-develop systems [21][28][40]. From a *software engineering* perspective, EUD is supportive of the trend of producing *generic applications* [2][24]. By “generic” is meant multifunctional, domain independent, or application generators, i.e. “over designed” functionality that can be configured to different user needs [26], or domain independent tools like groupware and basic drawing functionality, or “under designed” environments that support users in creating new applications [12]. For example, a groupware system can provide different users with different access rights to shared objects [33]. From the perspective of *organizational use*, the rationale for EUD is associated with the user diversity found in organizations employing advanced ICT. Users have different cultural, educational, training, and employment backgrounds. They are novice and experienced computer users (e.g. super user), ranging from the young to the mature, and they have many different abilities and disabilities [3][23][26].

2.1 Integrated EUD

EUD interrelates with software development in multiple ways, but (to the best of our knowledge) there are few studies that have examined EUD in terms of boundary crossing of two types of organizations (developer and customers). We survey the related work below EUD. We also include work that is not commonly associated with EUD in the survey.

Stevens and Wulf [33] presented a case study of inter-organizational cooperation from the steel industry in Germany. They analyzed the relationship between two engineering offices and a steel mill to identify patterns of cooperation that can serve as requirements for new designs. They found that there was tight coupling across organizational boundaries, but also competition between the units. EUD was proposed in terms of a component-based framework for tailoring a groupware application at runtime. The focus was on flexible access control for sharing material stored in electronic repositories among the interacting units. The new access mechanisms could be decomposed and integrated and the users were able to realize new access mechanisms that did not already exist in the groupware. By decomposing application components into simpler ones and assembling the parts into new compounds (intermediate building blocks) and applications, users can modify existing applications and create new ones, without accessing the underlying program code [40].

Eriksson and Dittrich [9] identified the reasons why tailoring should be integrated with software development. In a case study of a Swedish telecom provider, they found it was possible to provide end-user developers with the means to tailor not only individual applications, but also the infrastructure in which applications are integrated. According to the authors, this is an area that might change faster than applications, especially in rapidly changing business contexts. To support this form of tailoring in the organization, they studied tailoring needs to coordinate better with software development activities. In another study, Dittrich and Vaucouleur [4] found that customization practices of an ERP system they studied at several sites were at odds with software engineering practices, resulting in a discrepancy in terms of integrated environments for end-user development.

In a case study in an accounting company in Norway, the activities of end user developers were followed and analyzed using Activity Theory [26]. The authors show how the organization successfully initiated a program to train super users [17] in conjunction with introducing a new software application, Visma Business (VB). The research was formulated to address how super users engage in EUD activities in order to achieve an efficient use of VB, and how EUD activities were organized. In terms of organization, there was a certain division of labor within the community: 1) between the regular users and the super users, 2) between the super users and the application coordinator (acting as local developer), and 3) between the application coordinator and the professional developers. It was also interesting to find a new role for a local developer. This person's responsibility was primarily to perform EUD activities at a general level, to work closely with some of the more experienced super users in the offices, and to communicate with the professional developers. This person generalized the results of useful EUD activities and made local solutions available throughout the company.

Explicit and implicit channels for communication between developers and users for the purpose of end user development have been proposed in a variety of contexts, especially in the area of CSCW. For example Mørch and Mehandjiev [27] demonstrated that design rationale integrated with a tailor-enabled application could support indirect communication between developers and users and thus help end user developers to further develop their applications. Along the same lines, Stevens and Wiedenhöfer [34] developed a wiki-based help system for communication and information sharing to be integrated with standalone applications. It provides online help to a community of users and thus enhances communication between developers and users with the affordances of Web 2.0. The authors claim this form of integration creates a more seamless transition between the use context and the resolution of a problem due to the familiarity users have with Wiki-based systems [34].

3 Concepts for Analysis

We analyze our findings in terms of three theoretical perspectives on end-user development in order to account for a broad array of relevant concerns, ranging from computer science to application domains to organization of work: meta-design, modding, and co-configuration.

3.1 SER Model and Meta-design

SER (Seeding, Evolutionary growth, Reseeding) is a process model for integrating end-user development with software engineering [11]. It is different from user-centered design in HCI (e.g., prototyping) and from software engineering (e.g., specification driven methods). It has more in common with aspects of participatory design in that the SER model describes a sociotechnical environment for tailorable applications to be used over an extended period of time. It postulates that systems that evolve over a sustained time span must continually alternate between periods of unplanned evolutions by end users (evolutionary growth), and periods of deliberate restructuring and enhancement (reseeding), involving users in collaboration with designers [11].

The SER model makes a distinction between design time and use time, which distinguishes developers' activity from users' activity. Integrating these two types of software development activities is the aim of *meta-design*: a framework to provide end users with tools that allow them to tailor and further develop professional tools in their own context [10][12]. Meta-designers use their creativity to develop sociotechnical environments in which other (less technical oriented) users can be creative in their own areas of expertise. Meta-design as viewed from a software engineering viewpoint defines flexible design spaces for end-user developers. Examples are tailoring languages, application frameworks and EUD tools integrated with applications. This means the users interested in being active contributors should be supported in exploring an application's potential for being incorporated in new activities, and evolving its functionally to support new needs [10]. To the extent this can be accomplished without end users having detailed knowledge of programming, meta-design becomes a powerful framework and perspective for EUD.

The SER model has influenced the mutual development model we present below. In particular, we elaborate on evolutionary growth and reseeding and the dynamic interaction between them in the company we studied.

3.2 Modding

Modding is when users modify products by themselves, without the direct intervention of professional developers. The term is a slang expression derived from the word modify that refers to the act of modifying a piece of software or hardware, originally conceived in the gaming industry. Modding is an alternative way of including customers in product development processes. Modding can be seen to combine EUD and participatory design, in that it combines the inclusion of customers in both early and later stages of product development, depending on the customer's needs. By adopting this activity, modding can be seen as extending the design environment approach to EUD [12][28][40] by making it possible for customers to promote an array of ideas and needs in the early stages of product development, even before a given framework exists.

The outcomes of modding, called mods, range from minor alterations to very extensive variations of the original product [15][16]. An example of modding from the gaming industry is when hardcore players create hacks and figure out how to develop software add-ons to twist games' parameters, such as the creation of a "No Jealousy" patch, which lets characters have more than one lover without either one getting

jealous [20]. What is even more interesting is how the original product serves as a platform for further modding for customers.

Modding as an alternative approach to including customers in product development processes is a noteworthy concept since it engages the customer in different stages of the product development process. Modding is based on further development of an already existing platform. However, this must not be misunderstood. It does not mean the narrowing down of product development to simply be further development of already existing products, as is often the case with tailorable applications and evolutionary application development [24]. On the contrary, it appears that already existing products may be “opened up” by end-user contributions in terms of generating new ideas for functionality, new features, and even new products. In many ways, it is the concrete (executable) applications rather than the more abstract application frameworks and tailoring languages that best serve as a platform for end-user development [24].

3.3 Co-configuration

Engeström [7] [8] adopted the term co-configuration from Victor & Boynton [35] to enhance the theory of expansive learning in order to address a new form of work that involves user participation from customers and employees in the development of products. Co-configuration implies both a new form of work and a new way of learning. Engeström draws on the empirical findings of a broadband telecommunications firm in Finland, focusing on learning as joint creation of new knowledge and new practices by multiple stakeholders [7]. Engeström, following Victor and Boynton [35], defines co-configuration as an emerging historical type of work with the following general characteristics [7]:

- Adaptive and adaptable customer products or services, or more typically integrated product-service combinations
- A continuous relationship of mutual exchange between customers, producers, and the product-service combinations
- Continuous co-configuration and customization of the product-service-customer relationship over lengthy time periods
- Active customer involvement and input in the co-configuration work
- Multiple collaborating producers that need to operate together in networks within or between organizations
- Mutual learning from interactions between the parties involved in configuration actions.

From this description, we can understand the term co-configuration as a type of work that includes active participation from customers in developing their products. One of the characteristics of co-configuration work is the great degree of customer participation required in order for it to work. For example, when developing project planning software to fit a user organization and its work tasks, it is important to include users as participants in the process since they are the ones who know what kind of work tasks the project planning tools are supposed to support. However, not all companies will benefit by such a strategy. For example, to what degree is the company dependent on involvement from customers? What happens if some customers do not see the value of being part of such co-configuration work? To what degrees do the

customers actually participate? To what degree is it reasonable to expect that customers will continue to participate over lengthy time periods? It is probably realistic to assume that in today's world of mass consumption the majority of end users will not want to design or contribute to further development of the products they use. We chose to focus on those customers who took an active part in the case we report.

4 Method

Our objective is to construct a model of mutual development between customers and professional developers as seen from a EUD perspective. The case study is designed to extend our own previous efforts by treating the interaction of two organizations (developer and customer) as the unit of analysis [26][31]. We identify the sub-processes of the product development process studied. EUD is one component in this picture, but not the only one. By presenting the whole picture we wish to provide a comprehensive view of mutual development, which we present as different stages of activity, using examples and theoretical analyses to justify our claims. We used a qualitative approach as part of a case study. In addition, we used video and audio recorders to gather data. Moreover, we used open-ended interviews, focus groups and participant observations.

4.1 Categorizing Data

This section will elaborate on how the intermediate terms used to describe mutual development emerged as a result of analysis done while screening and analyzing data. The form of analysis used is 'template analysis,' which is the process whereby "the researcher produces a list of codes (a template) representing themes identified in their textual data [19]." This is both a top-down and bottom up process. Below, we have named some terms, more precisely the different stages of mutual development, representing different themes identified in the empirical findings. After identifying these themes, the data was analyzed with this in mind, using these themes as a template. King distinguishes three features in template analysis: *defining codes*, *hierarchical coding* and *parallel coding* [19].

Defining codes is to label a section of text with a code in order to index it as relating to a theme or issue in the data that the researcher has identified as important to his or her interpretation [19]. We had the research questions in mind the first time we went through the data, but in the second round of selecting data we categorized it accordingly. The categorization of "outer loop" and "inner loop" were used as "high-level codes," and may be connected with what King defines as *hierarchical coding*.

Hierarchical coding "is codes that are arranged hierarchically with groups of similar codes clustered together to produce more general higher order codes" [19]. The high-level codes of "inner loop" and "outer loop" roughly clustered the data into two different terrains, one about customer-initiated development activity (outer) and the other about software engineering (inner). This was done deliberately to create an overview of the data. Knowing that our area of interest was mostly on the "outer loop" product development process, the data was analyzed again for topics within this domain. It was found that within the interviews there existed some sub-processes of outer loop product development. They were identified as *Adaptation*, *Generalization*,

Tailoring, Improvement Request and *Specialization*. Using these terms or codes as a template, the data was searched again in order to support these sub-processes with empirical evidence.

Parallel coding is when the same segment of data is classified within two (or more) different codes at the same level [19]. In one instance, the same set of data excerpts was classified within the intermediate code “outer loop” and the lower order code *Specialization*, which is a stage within the inner loop product development. Therefore, parallel coding was used in this context.

5 Data and Analysis

At the end of the coding we ended up with the following five sub-processes (stages) of customer-initiated product development:

- *Adaptation*: Adaptation is when a customer requests an improvement to an existing product and the company chooses to fulfill the request. It becomes an Adaptation just for this customer. Sometimes, the customer has to pay for this, sometimes not.
- *Generalization*: Generalization occurs when a new version of an existing product is released and is available to more than one customer.
- *Improvement Requests*: This is when customers request the company for extra functionality, report bugs and usability problems, and is viewed from the customers’ perspectives.
- *Specialization*: Specialization is when the professional developers at the company create in-house builds. This is common in inner loop development processes where professional developers improve the products for their own internal work. This could potentially result in new features, but most often it entails refining the product, reorganizing program code, and removing bugs.
- *Tailoring* is about active end users who make adaptations on their own.

We justify these stages using the data extracts and analysis below. The two first extracts define basic issues (types of process) that resurface in the other extracts and in the analyses. The last three extracts represent four of the five stages.

5.1 Excerpt 1: Types of Improvement Request

In the first excerpt, the focus is on how a developer (informant) judges the Improvement Requests of the customer. This includes making a power decision as to what kinds of Improvement Requests to consider. The power to judge whether or not a customer Improvement Request should be accepted lies in the hands of the company’s professional developers. This excerpt does not go into detail about how exactly these Improvement Requests enter the company, but it does elaborate in what way the customers ask for Improvement Requests.

Informant: *Often when they (the customers) want Improvement Requests they ask me if I can make a change (to the existing product), according to some needs they have. In addition they put it (the Improvement Request) into a list we have on the Internet. We receive a lot of Improvement Requests and some of them are actually such good ideas that we want to*

integrate them into our products. And there are other ideas that are really bad. There are also some ideas that are not so good (but they are doable), therefore we incorporate them if they pay for it. When doing this we make special libraries for that particular customer. Then this does not become a part of the system (the product).

Improvement Requests turned out to be an important activity for communication with the company, requiring less technical expertise than Tailoring. Excerpt 1 is an example of how customers propose changes to the company's products without doing any local development. Excerpt 1 shows that an Improvement Request is one of the prerequisite sub-processes of Adaptation. It is when a professional developer creates a new feature for an already existing product in accordance with the customer's demands. At the end of this excerpt, the informant introduces the theme of how they get good, possible (doable) and bad ideas for further development. If an idea is labeled *good* it is accepted as is. When an idea is categorized as *possible* it means that the idea is plausible, but will not become a part of the general product. It might be accepted under contract (with payment), and turns into a local Adaptation. Finally, an idea labeled *bad* is rejected outright. Implicit in this example is the assumption that the company's employees are the ones who judge whether the Improvement Requests are *good*, *possible* or *bad* and have the freedom to make those distinctions.

As seen from a meta-design and SER perspective [11][12], Excerpt 1 may be interpreted as an example of boundary crossing, namely that submitting, receiving and handling of improvement request cross the boundary of two organizations (customer and developer). It also indicates some of the decisions that have to be made before the "evolutionary growth" of an application at a specific site can be accepted into the "reseeding" phase by company developers. In this way, Improvement Requests can help to bridge the gap between EUD and professional development.

The data in Excerpt 1 may have some commonalities with Engeström's notion of co-configuration. Item number two in the definition of co-configuration (see Integrated EUD) is about the *mutual exchange between customers, producers and the product-service combinations* [8]. Mutual exchange can be seen in this excerpt as well, between the customers issuing requests to the company and the professional developers handling these requests. The exchange for customers is getting the development they want, while the company receives money for performing the development (or more satisfied customers).

If a request is categorized as good or possible, the next stage of Adaptation takes place. During the second stage of Adaptation terms like patch, build and version become relevant, which we discuss below.

5.2 Excerpt 2: Types of Generalization

This is part of an interview one of the researchers had with one of the developers. The informant explains the software deployment (packaging) terms *patch*, *build* and *version* as part of an elaborated answer to a question about improvement requests:

Informant: There are three levels: we have a so-called patch, which is a quick fix to some sort of a problem. This is being sent out to the customer, which

is a (solution) right there and then. After the customer installs the patch, he tests if it works and then the problem is fixed. After a while, when we have made enough patches like this, we find new errors and the customers find errors and then we make a new complete program. That is what we call a build. On top of this, we have something we call versions; they could be (called) 3.4, 3.5, 3.5.1. They have more content and much more functionality.

Patch, build and version are the developers' responses to customers forwarding Improvement Requests in the Adaptation stage, which again can lead to Specialization and Generalization. *Patch* is understood as a quick fix to a problem. Patches are packaged extensions that fit specific versions. For example, if Word is being used to write some text and one's references in EndNote are lost each time text is converted into PDF, the company could be contacted. They will fix it and send back a so-called *patch*, which is small program (a software component) that may be installed on the computer and linked with the main program, and the problem is fixed. *Builds* result if the company has had many quick fixes, similar to the example with Word, and 2nd order problems emerge (i.e., problems connected to the compatibility of patches). Then they create a *build*, which is a compiled program. Builds are associated with Specialization. Finally, a new *version* is both an extension and a generalization. It is an extension (improvement) of a build, and a generalization when a new *version* is made available to new customers and to the existing customers when they are due for an upgrade according to their contract. Generalization is a borderline activity between inner loop and outer loop product development.

In Excerpt 2 it is evident that to a large extent, software development at the company proceeds with the SER model, as Fischer describes [11]. Excerpt 2 has a lot in common with the example Fischer uses to explain the reseeded phase, where open source software systems take some time to evolve, aided by using local (user created) extensions and the integration of patches (*evolutionary growth*), but eventually require major reorganizing in order to incorporate the patches and extensions in a coherent fashion (*reseeding*) [11]. In the company it happened like this: First the product evolves locally as a result of *patches* created in response to customer requests, and when this becomes unwieldy the company's professional developers create a *build*. Lastly, when the modifications become too numerous or are judged to be useful (good) for other (potential) customers, the developers create a new *version* of the product. However, Fischer does not distinguish between build and version. He uses the term *reseeding* for all developer activity associated with reorganizing multiple adaptations (patched systems) into unified (seamless) versions. Due to the complexity of this activity, it is useful to distinguish the multiple sub processes (types) of reseeded and the interaction between evolutionary growth and reseeded.

5.3 Excerpt 3: Improvement Request and Adaptation

Excerpt 3 below illustrates how the Improvement Requests, as elaborated in the excerpt above, are differentiated. It also shows what is meant by Adaptation.

Question: So, the rationale for a given upgrade lies with a specific customer, which means that a customer can be a part of setting the standards for what other customers receive.

Answer: Mm, but if what one customer suggests is far off, then we just make a local adaptation for that specific customer.

Question: So, this becomes a new version for you then?

Answer: What we have in addition to every menu choice is a so-called user option, it is placed in an “own” library, which can be linked, and allows us to do further product development.

What triggered the statement above is that one of the interviewers asked how the company develops their products. In sentence number two, the informant answers that if the customer’s request is “far off” they just make an Adaptation for this particular customer, as long as the customer pays for it. As mentioned above, this corresponds with an Improvement Request labeled *possible*. Excerpt 3 shows how an Improvement Request labeled *good* may become available to all customers. The informant acknowledges after some hesitation and with elaboration that the customers are to some extent “defining” what other customers receive of product upgrades. They do this by suggesting Improvement Requests and other customer-initiated activities such as Tailoring. However in most cases Improvement request that are responded to by an Adaptation, providing a custom-made product for this customer by using patches or user options with the current released version of the product. In the last sentence in Excerpt 3, the informant explains what is meant by (local) Adaptation. It is associated with a patched system installation that can be continually adapted (further developed) by user options that are deployed in a separate package (own library). When installed in the system, it appears as a separate menu with items for the various user options.

5.4 Excerpt 4: Generalization

The above excerpt introduced the term “user option,” which is a special kind of patch. The related terms user option, patch and new version will be clarified in Excerpt 4 below. The excerpt illustrates the generalization process.

Question: Do you have other examples of customers initiating new functionality to the product?

Answer: Yes, we have done it for BuildingCompany and ABB... (two large European engineering and consultancy companies)

Question: What sort of new functionality did they want?

Answer: Yes, well, it is. I don’t remember - it was years ago. I know that when they bought the product they had specific requirements that were originally not part of the product. But we wrote it into the contract as the functionality they wanted.

Question: Ok, so it was a part of the contract?

Answer: Yes, they wanted it within a specific time period. Their requirements were rather demanding regarding what they wanted us to make.

Question: Was it an add-on specifically made for BuildingCompany or..

Answer: No, it became a part of the product. Yes, it started as a patch, what we call a user option.

The informant underlines that a request for new functionality eventually became part of the company's general product portfolio and was made available to all their customers. It is an example of *Generalization*. It becomes clear that in this situation the request for new functionality that BuildingCompany asked for was something specific they needed. The company wrote their demands into the contract. This excerpt reiterates a point made above, that *good* Improvement Requests would be incorporated into the next version of one of their products.

The transition from Adaptation to Generalization is evident in Excerpt 4 since it describes an activity that involves one specific product (Planner) based on interaction with specific customers (Building Company in particular). The product has developed from small local extensions (patches and user options) to a basic core (in-house) version to a new (released) version where generally useful local adaptations are incorporated into the new release. We interpret the last sentence of the excerpt to mean a step-wise integration into the product (from specific to general) along three steps. It is associated with the combination of the utterance of "No" and "Yes" that signify a contradiction and disruptive (non incremental) transition (from Adaptation to Generalization). 1-2) Yes, it started as a special type of patch (user option), which is Adaptation, 3) no, it was only later incorporated into the product, which is Generalization. Adaptation represents the two first steps. First, the extra functionality BuildingCompany asked for is a *user option*, which means it is only available for this specific customer. Second, they want to make this available for later use, so they make a *patch* that the other customers can access upon demand, for example via the company's web pages. Third, when there is a *new version* of the product, the extra functionality (patches and user options) have been incorporated in the product and therefore made available to potentially all customers. In other words, we may say that there is a gradual development of the company's products over the years, many of which are based on local development initiatives and Improvement Requests to generalized versions and back to new initiatives for further development, as new user contexts appear.

Fischer and Oswald's SER model [11] suggests mutual dependency of evolutionary growth and reseedling, and this is supported by the findings reported here, namely that use time activity (Improvement Requests) can trigger design-time (Generalization) activity. It is also related to SER in a more indirect way, in that Adaptation as a user-oriented design-time activity can lead to Generalization.

Jeppesen underlines how a defining characteristic of modding is how "*final mods often are freely revealed,*" meaning that no users are excluded from using the new modified version" [15]. In the same way as final mods are freely available, the Adaptations made to products based on some customers' ideas become available for all customers in the Generalization stage, when the suggestions from customers are accepted and integrated into a new version of the product, as shown in the excerpt above.

5.5 Excerpt 5: Tailoring

Excerpt 5 shows how customers locally adjust a software product by end-user programming to create their own extensions. Excerpt 5, from an interview with a customer in the building industry, shows a customer stating that he has adjusted the product himself by writing code in the domain-specific language SQL.

Question: Have you requested any wishes or needs for local adaptations?

Answer: No, we have not got any special adaptations of the products (from the company). The reason for this is because I knew a great deal about SQL from earlier experience; therefore I managed to find a shortcut (of how to do it myself). I do not know the whole structure of the system, but it is available through ordinary documentation. There you get the whole (database) table structure and that has made it possible for me to find a shortcut through Access (a proprietary database management system) and allowed me to make some special (local) adaptations.

Question: So, in reality you have made your own adaptations to the products?

Answer: Yes, you may say that.

This excerpt illustrates Tailoring, which is the sub-process that most closely resembles EUD as a standalone activity. Microsoft Office Access is used in conjunction with one of the company's project planning tools for data storage.

In the first sentence of this excerpt the customer states that the company has not adjusted the products for them. It is discovered that the reason for this is because the customer has made some adaptations to the product himself. He has *tailored* the product. This was possible for the customer because the products are well documented. In addition, because this customer was familiar with SQL, a high-level database query language, it was natural for him to fix the problem himself to suit his needs. This excerpt is an example of what we refer to as *Tailoring*. In Tailoring, the customer actually locally adapts the product without any company involvement. This might mean creating a small program to work around an inefficient solution as shown in this excerpt.

The reason the customer is able to tailor the product himself is because he is an expert project manager and is interested in learning how to work around a problem or inefficient solution when it appears. In other words, he is a super user. As an example, he describes how he can access and reorganize database tables as he sees fit and in a way that meets his organization's needs. The cost of this is his time and the skills required for programming, albeit simplified with a database query language like SQL compared to programming languages like Java. The advantage is that he will be able to see results of his ideas implemented relatively quickly as compared to the turnaround time when ideas for change are submitted to the company via improvement requests. The interviewer asks if this is a way of doing local adaptation, and he confirms that his SQL programming can be perceived as such. If Tailoring is followed with an Improvement request, tailoring might contribute to further development at the general levels, as was illustrated in the previous excerpt.

In previous work, tailoring has been viewed as evolutionary application development [24]. This view ignored the role of professional development and reseeding, and explored the design space of evolutionary growth for end-user developers. According to the mutual development perspective, this view must be updated. Based on the data reported here, tailoring is better conceived of as *evolutionary design*, in the sense that the local (customer) solution serves as a design for the general (company) solution, assuming it is accepted.

The findings reported in this section have been condensed and depicted in the mutual development model shown in Figure 1. Excerpt 1 can be seen as clarifying the

informants’ perception of the terms *good*, *possible* and *bad*. Excerpt 2 has a similar role for the terms *patch*, *build* and *version* (*user options* are further distinguished in Excerpts 3 and 4). Excerpt 3 also underlines the processes of *Improvement Request* and *Adaptation*, which are related in that one feeds into the other. Excerpt 4 exemplifies the stage of *Generalization*. It illustrates how a product becomes available to all customers. Finally, Excerpt 5 illustrates *Tailoring* by showing how a customer with some programming knowledge modified the product himself. It should be stressed that we have focused on the activities that involve end users (company customers) and multiple perspectives on developer-user interaction. We do not yet have sufficient data to illustrate the *Specialization* stage.

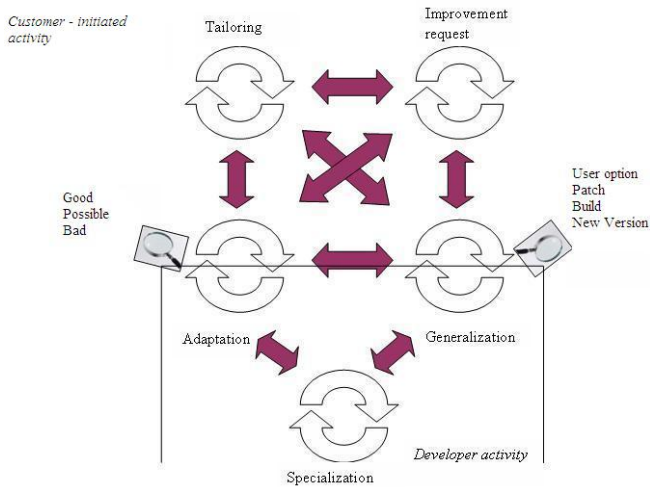


Fig. 1. Different stages of mutual development: developer activity and customer-initiated activity co-evolve; the arrows indicate dependencies. Specialization is not addressed in this paper because it does not interrelate directly with end-user activities.

6 Conclusions and Directions for Further Work

Our main research question and objective is how there is mutual development between customers, professional developers mediated by software products and ICT support systems in the company we studied. Our findings points to the components of the product development process studied. It was found that within the interviews there existed some sub-processes of mutual development (initially formulated during the preliminary analysis as customer-initiated product development) [1]. They were identified as *Adaptation*, *Generalization*, *Improvement Request*, *Specialization*, and *Tailoring*.

Mutual development is depicted in Figure 1. It is our first attempt to construct a model to integrate professional and end-user development [1]. Looking back, we see there are additional questions we would have liked to ask our informants, for example about the details of the customer-developer interactions. This was not possible in the current study. We cannot rule out that there may be sub-processes that have not been

identified, some that may have to be modified, and yet others that need to be elaborated. This is part of future work.

In spite of this, it is clear that EUD and professional development are interdependent, and represent two different activity systems, one (customer-initiated activity) feeds into the other (developer activity) and they co-evolve. This relationship is maintained because the developer organization (company) relies on input from active customers for continuation of its products as part of maintenance and consultation contracts, and to get innovative ideas for new products that can attract new customers. This is to some extent a result of the company's small size and its operation in a niche market. On the other hand, customers rely on the company for project planning tools, training and constancy services, the ability to interact with the company's developers, and in general the pleasure they get from seeing their suggestions for modification being incorporated in a later version of the product.

The five excerpts we have shown to justify our claims illustrate how the products in the company have evolved from specialized and locally adapted instances to more general and stable ones in interaction with customers. It goes through an elaborated process of specialization (refinement), adaptation (domain orientation) and generalization (one to many instances), starting with a stable (but non optimal) product version that is gradually extended with locally developed extensions, user options, and patches. At some point this configuration becomes unwieldy and the system is rebuilt. The new build may lead into a new version of the product if it will benefit the company and its other customers. Interaction between the stages is not unidirectional because new versions may lead to new local development and improvement requests, which repeat the process.

We have used theories and concepts developed by other researchers in EUD and adjoining disciplines, in particular meta-design [10][12], co-configuration [7][8], and modding [15][16] to discuss our findings at a more theoretical level. These findings are summarized as follows.

Findings According to the Meta-design and SER Perspective

- Customers being active either as designers of aspects of solutions or as producers of new ideas
- Interaction between customers and professional developers is the driving force of evolutionary development
- Professional developers adapting the products in accordance with customers' needs as main method to further develop the products
- Project planning tools evolving as a result of being used in specific contexts

Findings According to the Co-configuration Perspective

- Both customers and professional developers gain from customer-initiated product development
- Customers forwarding Improvement Requests and the company handling these form a sort of network
- Customers are active in the product development process
- Customer-initiated product development is a continuous process lasting for a long time

- When customers and professional developers interact in intimate ways to develop products, they can be considered collaborators

Findings According to the Modding Perspective

- Changes made to the company's products by users vary in complexity
- There are changes made solely by users
- Some modifications become available to all customers.
- Customer-initiated product development motivates technical-minded users
- Customers suggesting or designing new features of a product in a way "open it up" for further development
- When customers develop new features, it can be seen as a decentralized development activity

6.1 Directions for Further Work

Our results can furthermore be extended along directions advocated by researchers in user-driven innovation, participatory design, and evolution of technology.

Users can be creative and contribute to development without designing, and end-user development is often triggered by innovative use of a tool as a first step to address a breakdown in use. Norman [30] suggests workarounds and hacks as two techniques people draw on in everyday situations when coping with difficult-to-use tools. Many companies are starting to realize that innovation can arise not only from the IT department, but also from the interaction with partners, suppliers, and customers. Eric von Hippel, a pioneer and long-time champion of studying users as innovators in product development coined the term user-driven innovation. He has introduced a method for identifying sources of innovation, following "lead users" [38]. Many of the innovations he has studied originated with lead users' novel use of an existing product or an adaptation of a product based on knowledge of a related product. For example the motocross series of bikes manufactured for teenagers during the 1960s and 1970s originated as result of teenagers' desire for their bikes to resemble adult motocross bikes.

Researchers in information systems have used terms like super users [17], gurus [14], and boundary spanners [36] for a similar role as lead user. They share the view that these users help to democratize the design process, and study them by drawing on insights derived from empirical data gathered from user organizations, like we have done in this paper.

In the area of software development, participatory design [6][18], directed observation [30], and strategic ethnography [32] are methods for addressing similar issues. Directed observation means to seek out and analyze the workarounds, hacks, and clever improvisations lead users and ordinary people create at work and at home [30]. Strategic ethnography is longitudinal studies following artifacts (packaged software) as they evolve over time, which has been referred to as capturing the biography of these artifacts [32].

Based on a study of user driven innovation in an open source community von Hippel [37] observed "the ability of user communities to develop and sustain exceedingly complex products without any manufacturer involvement is remarkable." He

identifies the conditions that favor user innovation and explores how circumstances evolve, sometimes to include commercial manufacturers and sometimes not [37]. When commercial manufactures are included in the loop, the resulting inter-organization activity structure can be compared with “mutual development.” When commercial manufactures are not included in the loop, the resulting organization can be compared with the emerging “user manufacturing” model. Aided by the Internet and Web 2.0 applications to support communication and information sharing and most recently “mashing” (combining existing web 2.0 applications to create new ones), this model has the potential to attract new interest in end-user development due to the enormous success of this platform to attract self-motivated contributors [13]. To leverage this potential for end-user tailoring and evolutionary design is an area for further research in EUD.

In their study, Douthwaite and colleagues [5] state the following “as technology and system complexity increase so does the need for interaction between the originating R&D team and the key stakeholders (those who will directly benefit and be penalized from the innovation).” This is a hypothesis that requires further testing. It implies when software products increase in complexity, the interaction between developers and customers must proportionally increase in order to successfully manage further development and sustain the product. Otherwise, users will seek out other products that are simpler to use. The reason for increasing customer interaction as complexity unfolds is that a successful technology represents a synthesis of the developers and key stakeholder knowledge sets, and creating this synthesis requires more iteration and negotiation as complexity increases [5]. This is a hypothesis that ought to be explored in software evolution as well, in particular when end-users are enabled by EUD environments and rich feedback channels to more experienced developers.

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References

1. Andersen, R.: Customer-initiated product development: A case study of adaptation and co-configuration, Master’s thesis, Dept. of Informatics, University of Oslo, Norway (2008)
2. Bansler, J.P., Havn, E.: Information systems development with generic systems. In: Walter, W.R.J. (ed.) Proceedings from Second European Conference on Information Systems, pp. 30–31. Nijenrode University Press, Breukelen (1994)
3. Costabile, M.F., Foglia, D., Fresta, G., Mussio, P., Piccinno, A.: Software environments for end-user development and tailoring. *PsychNology Journal* 2(1), 99–122 (2004)
4. Dittrich, Y., Vaucouleur, S.: Practices around customization of standard systems. In: Proceedings of the 2008 international Workshop on Cooperative and Human Aspects of Software Engineering (CHASE 2008), pp. 37–40. ACM Press, New York (2008)

5. Douthwaite, B., Keatinge, J.D.H., Park, J.R.: Why promising technologies fail: The neglected role of user innovation during adoption. *Research Policy* 30(5), 819–836 (2001)
6. Ehn, P., Kyng, M.: Cardboard computers: Mocking-it-up or hands-on the future. In: Greenbaum, J., Kyng, M. (eds.) *Design at Work: Cooperative Design of Computer Systems*, pp. 169–195. Lawrence Erlbaum, Hillsdale (1991)
7. Engeström, Y.: New forms of learning in co-configuration work. *The Journal of Workplace Learning* 16, 11–21 (2004)
8. Engeström, Y.: Enriching the Theory of Expansive Learning: Lessons From Journeys Toward Coconfiguration. *Mind, culture and activity* 14(1-2), 23–29 (2007)
9. Eriksson, J., Dittrich, Y.: Combining tailoring and evolutionary software development for rapidly changing business systems. *Journal of Organizational and End-User Computing* 19(2), 47–64 (2007)
10. Fischer, G., Giaccardi, E., Ye, Y., Sutcliffe, A.G., Mehandjiev, N.: Meta-design: A manifesto for end-user development. *Comm. ACM* 47(9), 33–37 (2004)
11. Fischer, G., Ostwald, J.: Seeding, evolutionary growth, and reseeding: Enriching participatory design with informed participation. In: *Proceedings of the Participatory Design Conference (PDC 2002)*, pp. 135–143. ACM Press, New York (2002)
12. Fischer, G., Scharff, E.: Meta-design: Design for designers. In: *Proceedings 3rd International Conference on Designing Interactive Systems (DIS 2000)*, New York, pp. 396–405 (2000)
13. Floyd, I.R., Jones, M.C., Rathi, D., Twidale, M.B.: Web mash-ups and patchwork prototyping: User-driven technological innovation with Web 2.0 and open source software. In: *Proceedings of the 40th annual Hawaii international Conference on System Sciences*, pp. 86–96 (2007)
14. Gantt, M., Nardi, B.: Gardeners and gurus: Patterns of cooperation among CAD users. In: *Proceedings of the Conference on Computer-Human Interaction (CHI 1992)*, pp. 107–117. ACM Press, New York (1992)
15. Jeppesen, L.B.: Profiting from innovative user communities: How firms organize the production of user modifications in the computer industry. Working Papers 2003-2004, Dept. of Industrial Economics and Strategy, Copenhagen Business School, Denmark (2004)
16. Jeppesen, L.B., Molin, M.J.: Consumers as co-developers: Learning and innovation outside the firm. Working Papers, 2003-01, Dept. of Industrial Economics and Strategy, Copenhagen Business School, Denmark (2003)
17. Kaasbøll, J., Øgrim, L.: Super-users: Hackers, management hostages or working class heroes? A Study of user influence on redesign in distributed organizations. In: *Proceedings of the 17th Information Systems Research Seminar in Scandinavia (IRIS-17)*, pp. 784–798. Dept. of Information Processing Science, University of Oulu, Finland (1994)
18. Kanstrup, A.M., Christiansen, E.: Selecting and evoking innovators: Combining democracy and creativity. In: *Proceedings of the 4th Nordic Conference on HCI (NordiCHI 2006)*, pp. 321–330. ACM Press, New York (2006)
19. King, N.: Template analysis. In: Symon, G., Cassell, C. (eds.) *Qualitative methods and analysis in organizational research: A practical guide*, pp. 118–134. Sage, London (1994)
20. Knight, W.: Supernatural powers become contagious in PC game (April 28, 2008), <http://www.newscientist.com/article.ns?id=dn6857>
21. Lieberman, H., Paterno, F., Wulf, V. (eds.): *End-user development: Empowering people to flexibly employ advanced information and communication technology*. Kluwer, Dordrecht (2006)
22. Mehandjiev, N., Bottaci, L. (eds.): *End-user development: Special issue of the Journal of End User Computing* 10(2) (1998)

23. Mehandjiev, N., Sutcliffe, A.G., Lee, D.: Organisational views of end-user development. In: Lieberman, H., Paterno, F., Wulf, V. (eds.) *End user development: Empowering people to flexibly employ advanced information and communication technology*. Kluwer Academic Publishers, Dordrecht (2005)
24. Mørch, A.: Evolving a generic application into a domain-oriented design environment. *Scandinavian Journal of Information Systems* 8(2), 63–90 (1996)
25. Mørch, A.: Three levels of end-user tailoring: Customization, integration, and extension. In: Kyng, M., Mathiassen, L. (eds.) *Computers and Design in Context*, pp. 51–76. MIT Press, Cambridge (1997)
26. Mørch, A.I., Hansen Åsand, H.R., Ludvigsen, S.R.: The Organization of End User Development in an Accounting Company. In: Clarke, S. (ed.) *End User Computing Challenges and Technologies: Emerging Tools and Applications*, pp. 102–123. Information Science Reference, Hershey (2007)
27. Mørch, A.I., Mehandjiev, N.D.: Tailoring as collaboration: The mediating role of multiple representations and application units. *Computer Supported Cooperative Work* 9(1), 75–100 (2000)
28. Mørch, A.I., Stevens, G., Won, M., Klann, M., Dittrich, Y., Wulf, V.: Component-based technologies for end-user development. *Comm. ACM* 47(9), 59–62 (2004)
29. Nedic, D., Olsen, E.A.: Customizing an open source web portal framework in a business context: Integrating participatory design with an agile approach. Master's thesis, Dept. of Informatics, University of Oslo, Norway (2007)
30. Norman, D.A.: Workarounds and hacks: The leading edge of innovation. *Interactions* 15(4), 47–48 (2008)
31. Nygård, K.A., Mørch, A.I.: The Role of Boundary Crossing for Knowledge Advancement in Product Development. In: *Proceedings Int'l Conf. Computers in Education (ICCE 2007)*, pp. 183–186. IOS Press, Amsterdam (2007)
32. Pollock, N., Williams, R.: *The biography of the enterprise-wide system or how SAP conquered the World*. Routledge, London (2008)
33. Stevens, G., Wulf, V.: A new dimension in access control: Studying maintenance engineering across organizational boundaries. In: *Proceedings of CSCW 1992*, pp. 196–205. ACM Press, New York (2002)
34. Stevens, G., Wiedenhofer, T.: CHIC - A pluggable solution for community help in context. In: *Proceedings of the 4th Nordic Conference on HCI (NordiCHI 2006)*, pp. 212–221. ACM Press, New York (2006)
35. Victor, B., Boynton, A.C.: *Invented here: Maximizing your organization's internal growth and profitability*. Harvard Business School Press, Boston (1998)
36. Volkoff, O., Strong, D.M., Elmes, M.B.: Between a Rock and a Hard Place: Boundary Spanners in an ERP Implementation. In: *Proceedings of the 8th Americas Conference on Information Systems*, pp. 958–962 (2002)
37. von Hippel, E.: Innovation by User Communities: Learning From Open-Source Software. *MIT Sloan Management review* 42(4), 82–86 (2001)
38. von Hippel, E.: *Democratizing Innovation*. MIT Press, Cambridge (2005)
39. Wulf, V., Golombek, B.: Direct activation: A concept to encourage tailoring activities. *Behaviour & Information Tech.* 20(4), 249–263 (2001)
40. Wulf, V., Pipek, V., Won, M.: Component-based tailorability: Enabling highly flexible software applications. *Int. J. Hum.-Comput. Stud.* 66(1), 1–22 (2008)

Article II

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Article III

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Mutual development in mass collaboration: Identifying interaction patterns in customer-initiated software product development



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ABSTRACT

In this paper we investigate computer-supported collaborative learning (CSCL) and innovation in a large-scale distributed setting. Get Satisfaction (GS), a social media platform for involving customers in product development activities, is our case study. In order to identify how end users contribute to product development, we researched the interactions between end users, champions, and professional developers in this online community as they jointly constructed a shared artifact (a web application). We collected publicly available platform interaction data over a six-month period (N = 229 users). The methods we employed are social network analysis (SNA) and interaction analysis (IA), which we combined in a mixed-methods design. At the network level, we identified key actors according to centrality measures. At the interaction level, we zoomed in on specific interactions. We propose a model of mass collaboration in terms of four interaction patterns: 1) *gatekeeping*, control of excessive information sharing, 2) *bridge building*, spreading information across groups in the network, 3) *general development*, allowing professional developers to create new software functionality and update existing software, and 4) *user-user collaboration*, facilitating non-centrally organized development activities, ranging from feature requests to local development. We discuss our findings and compare them with related research.

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1. Introduction

With the rise of web 2.0 technologies and social media there has been a turn toward users becoming content creators, and web platforms are now largely user-driven. There are many implications to this; for education, the internet is now a platform for collaborating, sharing and connecting people rather than just a source of information. This shift has enabled ordinary people to become active contributors by interacting in distributed settings and in multiple configurations, contributing a range of different skills and expertise. This “bottom-up” approach to knowledge production has challenged the “top-down” approach prevalent in other areas (e.g. Encyclopedia Britannica vs. Wikipedia; predefined curriculum vs. self-driven learning) and is characterized by collective and open-ended production where an anonymous mass constitutes an important stakeholder. A common term for this is *mass collaboration* (Cress, 2013; Tapscott & Williams, 2008).

The essence of mass collaboration resides not only in new technologies and enhanced connectivity but also in the interaction and collaboration of a large number of participants from different places and time zones (Halatchliyski, Moskaliuk, Kimmerle, & Cress, 2014) and in the creation of shared artifacts (Moen, Mørch, & Paavola, 2012; Paavola, Lipponen, & Hakkarainen, 2004). New opportunities for collaboration have become possible through social media, where users can contribute to knowledge building in the large, such as on Wikipedia (Cress, 2013). A consequence of this for education is that small group collaboration needs to be understood within the framework of mass collaboration. However, the majority of studies in the field of computer-supported collaborative learning (CSCL) investigate collaboration and knowledge building in small groups and classrooms (Scardamalia & Bereiter, 2006; Stahl, Koschmann, & Suthers, 2006). In the present study, we used empirical data from the Get Satisfaction (GS) online community to investigate interaction between end users, champions, and professional developers in their joint effort to improve a software product. According to Heiskanen, Hyysalo, Kotro and Repo (2010), there is a need for improved research methods for investigating product development collaboration between professional developers and end users, as previous studies have glossed over moment-to-moment interactions and knowledge sharing in user-

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developer relations. Our approach is unique in that it combines two traditions: CSCL and innovation studies. To accomplish this, we used two levels of data: fine grained empirical data of social interactions and a global view of the network and its social structures. We analyzed these two levels in conjunction through a mixed-methods framework to propose interaction patterns of user-developer collaborations.

The research question guiding our inquiry is “*What are the patterns of interaction between end users and professional developers in a mass collaboration community, as seen from a mutual development perspective?*” The first part of the question addresses the network level (information paths and powerful actors), and the second part incorporates what the participants discuss and what roles they perform. We wanted to investigate both the interaction patterns of the online GS community and focus on some specific social practices in the community during mutual product development in order to extend prior research. In our previous work (Andersen & Mørch, 2009; Mørch & Andersen, 2010), five sub-processes of user-developer interactions were identified at the small-group level, leading to the formulation of the term “mutual development.” Here, we take this one step further by scaling up from small-group collaboration to mass collaboration and integrating SNA and IA.

Several researchers acknowledge social network analysis (SNA) as a highly relevant and necessary research method for describing and understanding interaction patterns in CSCL (Cress, 2013; Halatchliyski et al., 2014). For example, Halatchliyski et al. (2014) have underscored how SNA is a unique and largely unexplored method for tackling the large-scale dimensions of mass collaboration within CSCL. De Laat, Lally, Lipponen, and Simons (2007) have used SNA in a mixed-methods approach to provide an analytical framework for understanding message exchanges among mass collaboration participants, capturing a richer, and more accurate, picture of the complexity of such conversations. Our approach differs from previous studies in two ways: 1) it combines SNA with interaction analysis (IA) and 2) it explores patterns of interaction around the development of a software artifact.

The paper is organized as follows: First, we survey related work. Then, we describe our case study and the context for the study. Next, we present and argue for our mixed-methods approach to data collection and analysis. We then present and analyze our empirical data by focusing on topical findings, presenting representative excerpts as instances of mass collaboration in customer-initiated software product development. We compare our findings with results reported in the literature we surveyed. Finally, we summarize our findings and suggest some directions for future research.

2. Literature review

2.1. Mass collaboration

Tapscott and Williams (2008) coined the term “mass collaboration” to describe how people can join forces in self-organized communities to dynamically produce new goods and services. Their work has not been without critique. For example, Elliott (2007) claimed that they failed to provide an adequate definition or criteria for discerning collaboration from other collective activities such as cooperation and coordination, making the term a buzzword and stripping it of analytical value.

Cress (2013) differentiated between formal and informal learning when she defined mass collaboration, emphasizing that formal learning involves knowledge building in smaller groups in classroom settings, whereas mass collaboration is about knowledge building “in the wild,” usually outside educational institutions and

often in informal or semi-formal contexts of work and leisure activities. She found that these activities induce individual learning while demonstrating collaborative knowledge creation in wiki-based systems, further developing shared knowledge artifacts (Cress, 2013).

Halatchliyski et al. (2014) have discussed the relevance of mass collaboration for CSCL, proposing collective knowledge to be constituted as substance and by participation. By studying article production in Wikipedia, their study shows how collective knowledge is manifested in the structure of artifacts and can be traced back to the collaborative activity of authors with different levels of experience and expertise (Halatchliyski et al., 2014). Wikipedia's interconnected articles represent a network and were thus analyzed using a network analysis approach. This form of mass collaboration was defined as a knowledge building activity: creating shared knowledge based on existing, openly accessible knowledge in collaboration with many other users.

Forte (2015) is critical of the use of the term “knowledge building” in conjunction with mass collaboration, arguing that the discursive processes associated with article creation in Wikipedia cannot be associated with knowledge building. Yet, despite the critique of the collaborative learning potential of Wikipedia discourses during article creation and discussion, Forte (2015) agrees there has been little attention paid to how information is selected, vetted, and verified by learners in this community. Our study differs from these studies in that we address another form of mass collaboration, mutual development, manifest in two ways: 1) there is an asymmetrical relationship between the participants, professionals (software developers) and amateurs (customers and end-user developers) and 2) the goal of their activity is to produce both concrete (software tools) and abstract (knowledge) artifacts.

2.2. SNA studies in CSCL research

De Laat et al. (2007) used social network analysis to study patterns of interaction in a networked learning community, investigating how its members share and construct knowledge. The authors used a mixed-methods approach, combining content analysis, critical event recall and SNA.

Siqin and colleagues (2015) investigated synchronous discourses between 27 Chinese undergraduate students collaborating in fixed groups during an introductory research methods course. They used a multifaceted analysis (involving social network analysis and content analysis) to assess online discourses and examine its potential relationship to individual learning throughout the course, as well as to examine different aspects of collaboration.

Martinez et al. (2006) have suggested that SNA can serve as an appropriate method for studying interaction patterns and provided examples of this in three different CSCL scenarios. They demonstrated how effective the method is for supporting the study of participatory aspects of learning at the network level.

Our study differs from previous studies in that we used a mixed-methods approach, combining SNA and IA, and applied this to discourse processes in mass collaboration. Our work builds on the notion of “collaborative knowledge creation” developed in the European KP-Lab (Moen et al., 2012; Paavola et al., 2004) and integrates CSCL with innovation studies.

2.3. User-driven innovation

User-driven innovation (UDI) refers to innovation by end users, customers, or consumer of products. Eric Von Hippel (2005) argued that integrating active users in companies' product development processes may lead to product innovation and value creation. He introduced a method for identifying sources of innovation by

following “lead users.” A lead user is an inventor of something (product, feature, or idea) that is picked up and transformed into an innovation by a company or an early adopter and champion of the product. UDI has been studied in open-source development (OSD) and thus is connected with mass collaboration in the sense that open source development was a source of inspiration for the notion of “peering” in mass collaboration (Tapscott & Williams, 2008).

The private-collective model of innovation is a conceptual framework for understanding UDI (Von Hippel & Von Krogh, 2003). It combines the private-investment model and the collective-action innovation model in order to explain the creation of public goods through private initiatives. It is based on the assumption that innovators who privately participate in creating public goods benefit more than free riders who consume those goods. A similar process occurs in mass collaboration on software development when interested users have the skills and tools to locally adapt (e.g., tailor) the software to their own needs (e.g., through hacks, mods, and other local development techniques) (Mørch, Hansen, & Ludvigsen, 2007). Collaborative tailoring of software by end users can bring benefits to a group working together to locally adapt a shared software system (Kahler, 2001). Based on a survey of previous work and an empirical study, Kahler (2001) suggested eight design principles for collaborative tailoring: 1) giving “administrator rights” to users to access, modify, or share tailored files, 2) sharing tailored files, 3) browsing tailored files, 4) providing users with awareness of others’ tailoring activities, 5) making annotations and automatic descriptions possible, 6) allowing for the exploration of tailoring files, 7) making administration and coordination easy, and 8) supporting a tailoring culture. This form of collaboration demonstrates the benefits of involving end users in the development process. Our analysis is informed by the concept of mutual development (Andersen & Mørch, 2009; Mørch & Andersen, 2010), or interaction between two interdependent software development activities: end-user (local) development and professional (in-house) development.

3. Case description and participants

The data presented in this paper is from a case study of Get Satisfaction (GS), a company (Get Satisfaction, 2016) which offers online customer management tools and provides a community platform for facilitating collaboration and interaction between participants, most of whom are customers either of GS itself or a company using GS tools. Get Satisfaction was established in 2007 and empowers more than 63,000 online communities; it has more than 9,600,000 visitors a month (as of 2015). The object of this study was collaboration on the GS platform in order to further co-develop it; we followed one of the communities over a six-month period in 2012–2013.

The support community at Get Satisfaction is continually evolving and is organized around question/answer (discussion)

forums, where anyone who is registered can start a new thread or topic and tag it with one of the system’s four thread categories: 1) Ask a question, 2) Share an idea, 3) Report a problem, and 4) Give praise. A screenshot of these categories can be seen in Fig. 1.

Table 1 shows the enrollment data for all threads during the time of the study. GS employees are referred to as developers, customers are referred to as end users, and champions belong to both classifications. Champions are customers appointed by GS employees after demonstrating extraordinary skills with GS software. They are given special privileges and may become part-time GS employees, paid for their support to the community.

Participants contribute by posting new messages, replying to previous messages, commenting, identifying moods, “liking” proposals, and rating each other’s contributions by giving “stars.” Fig. 2 is a screenshot of a few conversations from the “Share an idea” category.

The GS online community is reminiscent of a social media platform. We were interested in studying the collaboration spaces in this community during mutual development, with a focus on how new ideas for the further development of existing products are initiated, discussed, and spread in the community, captured by talk (text messages) inside the discussion threads, and emerge as recurrent interaction patterns in mass collaboration.

4. Methods and research design

4.1. A mixed-methods approach

We used a mixed-methods research approach to address the research question; this means that both quantitative and qualitative data were used (Tashakkori & Teddlie, 2010). We combined social network analysis and interaction analysis (Fugelli, Lahn, & Mørch, 2013). Relational aspects of social structure were the unit of analysis for SNA, and conversational turn taking in discussion forums was the unit of analysis for IA. Roughly speaking, we used SNA to describe the “climate” of our data and IA to describe the “weather.” This means we used SNA to get an overview and identify global attributes such as the most powerful participants, how they emerge as such, what subgroups they belong to, and how discussion forums and individuals are connected across all forums. We

Table 1

Tree snapshots of participation count according to user groups in Get Satisfaction forums over six-month intervals. The vast majority of participants are end users (customers).

Overview	March 2012	September 2012	March 2013
Topics posted	13,512	14,850	19,747
Participants (all)	259,119	262,017	269,280
Champions	29	29	47
Employees	43	43	50
End-users	259,047	261,945	269,183

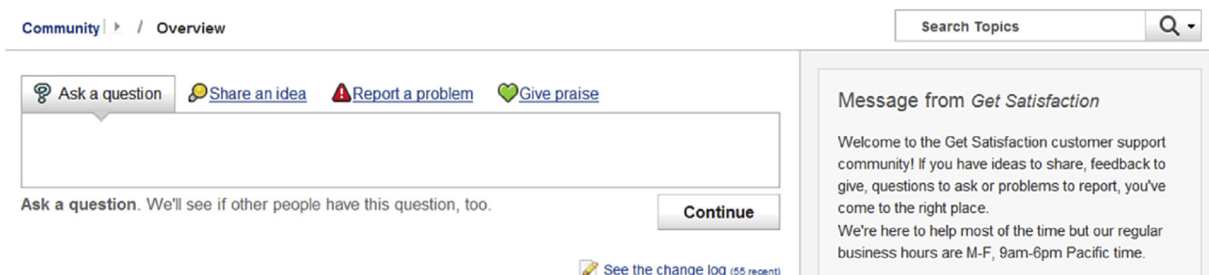


Fig. 1. Screenshot of the online support community and the four different categories for tagging discussion threads.

Community | Topics | Ideas

Search Topics

over 3 years ago

Add notification preferences that are product-specific

Allow notification preferences for topics in a particular product, rather than all topics from a company. Like this:

I'm one of the ones who would LOVE this feature.

Company Notifications

IZEA
You are an Admin of IZEA

Notify me of all new topics in IZEA
 Notify me of every new topic and every new reply in IZEA
 Notify me of every new topic in SocialSpark
 Notify me of every new topic in PayPerPost v4
 Notify me of every new topic in Sponzal

Save Company Notifications

29 PEOPLE LIKE THIS IDEA +1 follow

Implemented

Create a new topic

ABOUT THIS IDEA

36 REPLIES

3 PROMOTED RESPONSES

20 PEOPLE PARTICIPATING

OFFICIAL REPRESENTATIVES

CO-FOUNDER

PRODUCTS & SERVICES

Get Satisfaction Web App

TAGGED

communication email

over 3 years ago

You know what else would be pretty awesome and not hard to do? If the emails had the product name in the subject so I could at least set up mail filters.

5

comment good point!

over 3 years ago

Please please please... this has been in progress for over 2 years! Come on guys... this is seriously limiting our organizations adoption of GetSatisfaction.

I'm really quite frustrated, that such a basic functionality is STILL not available.

3

comment good point!

over 3 years ago

I like [redacted]'s idea. That feature would really make my life easier!!!

I'm Looking forward to the update

comment good point!

Fig. 2. Two screenshots of a discussion thread “Add notification preferences that are product-specific.” The topmost image shows the message that spawned the thread, and some replies are shown below.

used IA to go into the details of topic of conversation. IA is not commonly used in conjunction with SNA because SNA largely depends on quantitative data and IA on qualitative data, therefore a mixed-methods approach (Tashakkori & Teddlie, 2010) was used to combine them, which we explain below.

4.2. Collecting the empirical data

Virtual ethnography, researching internet communities (Hine, 2008; Kozinets, 2010), is the method we employed to collect the data. Virtual ethnography was a plausible method because the interactions are naturally occurring in the GS support community

(i.e., they are a publicly available social phenomenon). When gaining access to the discussion threads, no login name or password credentials were needed; the information was open. However, the first author also sent a letter to GS asking for permission to conduct research on their social media platform. Our participant observation approach is referred to as non-obtrusive (Kozinets, 2010) or “fly on the wall” (Hine, 2008), meaning we as researchers were not visible in the online community during field research as we did not post anything. The first author followed the postings of the support community from the beginning of March 2012 to the end of August 2012. Additionally, earlier discussion threads that had been marked with the tags “Share an idea” and

“Give praise” were scanned. When collecting the empirical data we as researchers are obliged to reveal as much as possible about the nature and aim of our studies to our informants, as well as providing information about our methods (Boellstorff, Nardi, Pearce, & Taylor, 2012). However, the notion of informed consent in virtual ethnography is difficult to follow through. Therefore, a passive consent for each discussion thread being analyzed in GS online community was created. The first author gained passive consent by posting a message to the respective discussion threads and informing the participants that the discussion thread was part of a research project and if some persons in the community did not want to participate they could opt out by sending an email to the first author and the person's data would be removed from the research project. None chose to use this option.

4.3. Selecting and categorizing the empirical data

The selection of the empirical data, participants, and population were done in steps. First, we decided to extract 41 discussion threads from the GS support community. These threads were selected due to their relevance to our research question and our research interest in mutual development (Andersen & Mørch, 2009, 2013; Mørch & Andersen, 2010). This led us to the top-level categories of “Share an Idea” and “Give Praise” because the process of mutual development starts with end users sharing an idea for developing a product further (Andersen & Mørch, 2009; Mørch & Andersen, 2010). Sharing an idea entails proposing an idea for improvement to (parts of) an existing product (Fig. 1). Giving praise means to credit those who do a substantial amount of work for others in the community. To capture the historical record and context for the interactions we decided to go six months back in time to collect those discussion threads that were still ongoing when we started data collection. From there, we chronologically focused on the 41 threads. We ignored the two other sub-communities (“Ask a question” and “Report a problem”), mainly for practical reasons. Due to the large numbers of participants (269,280) and postings (19,747) (see Table 1), it was necessary to narrow down the data in order to perform the research; from this, the need for new methods emerged, and we chose to conduct SNA in combination with IA. Data selection and categorization followed a two-step zoom-in process: 1) network data selection and 2) interaction data selection.

4.3.1. Network data selection

We used a collection of related software tools to perform our network analysis. The first author used a combination of Discourse Network Analyzer (DNA), University of California Irvine NETwork (UCINET), and NetDraw. DNA was used to collect the empirical data by transforming text-based conversational data into a formal network (Leifeld, 2010). The first author manually coded 4275 lines of forum messages into DNA, generating a set of higher order codes before exporting it to UCINET for SNA analysis. The selected population included 229 different users who were affiliated with 41 discussion threads, involving 546 code statements (utterances) and 31 higher order codes (Table 2). UCINET (Borgatti, Everett, & Freeman, 2002) represents data as matrices and can perform matrix operations to generate results. The results are presented as tables of measures of nodes and visual displays of networks of

nodes and ties using the drawing tool NetDraw (Borgatti et al., 2002).

At the network level, we identified the most active discussion threads and participants (nodes) according to centrality measures (Freeman, 1979). We selected the 20 most active threads and narrowed the field further by choosing threads that revealed cross-disciplinary (developer-user) interactions (i.e. informed by our research question). We then selected four empirical excerpts from conversations occurring in the most central and largest discussion threads according to degree centrality and betweenness centrality (Freeman, 1979). In addition we screened the data from a qualitative perspective and looked for relevant data according to our research question.

4.3.2. Interaction data selection

We thematically coded the interaction data (textual conversations) using template analysis. We included all utterances in each of the four empirical excerpts that were chosen. The essence of template analysis is that the researcher produces a set of codes (a “template”) representing themes identified in their textual data (King, 1998). This combines top-down and bottom-up analysis, resulting in a set of intermediate terms (higher order codes in Table 2) to create the templates. King (1998) distinguishes three features of template analysis: *defining codes*, *hierarchical coding*, and *parallel coding*. Examples of defined codes are “end user sharing an idea for feature request,” “user providing solution for suggested feature request,” “feature request implemented into general product,” and “champion providing solution for suggested feature request.” We then went through the empirical data once more in order to cluster it into part-whole groups, as an approach to hierarchical coding (King, 1998). Examples of these higher order codes were “further development of the product,” “general development,” “customer-initiated development,” and “user-user collaboration.” Parallel coding, which refers to the classification of the same segment within two different codes at the same level, was not relevant to our data analysis (King, 1998).

4.4. Data analysis

Data were analyzed both quantitatively and qualitatively; first, SNA was used to get an overview of the totality of data (network structure and powerful actors), and then IA was used on individual messages (what is talked about). This was not a strict linear process; we moved between scanning SNA and IA data.

4.4.1. Social network analysis

As a quantitative approach to studying large online communities, SNA provides a set of techniques and operations for analyzing the relational aspects of social structures (Scott, 2001), drawing on a library of algorithms and computational techniques (Borgatti, Everett, & Johnson, 2013; Freeman, 1979). We computed the degree centrality and betweenness centrality for each actor (Freeman, 1979) using UCINET (Borgatti et al., 2002). These measures were chosen because they were relevant to our research focus and allowed us to identify powerful actors in the network. Degree centrality is defined as the number of ties/links incident upon a node (Scott, 2001). In our case, this means the number of messages a person has posted to a discussion thread, and for discussion thread nodes the number of participants who post in a thread. A person with a high degree centrality has “selection power” (i.e., the ability to choose among alternatives, e.g. persons or threads) and it makes this person less dependent on any specific actor or thread (Hanneman & Riddle, 2005).

Betweenness centrality, on the other hand, is defined as the number of times a node is on the shortest path between two other

Table 2
Overview of the population coded in DNA (Discourse Network Analyzer).

Participants	Discussion threads	Higher order codes	Utterances
229	41	31	546

nodes in a network (Freeman, 1979). This means that the more persons that are dependent on a user to make connections with others in the network, the more power that user has, which is a form of “control power” (Hanneman & Riddle, 2005). In our case, betweenness centrality can tell us the probability of a user being in a position to share or withhold information or otherwise exercise control over who receives information in the community. A person with high betweenness centrality in the GS community contributes to several discussion threads but has few postings in each thread, contributing mainly to those threads that are likely to be decisive (e.g., succeed in or, alternatively, fail to implement a new idea). Degree and betweenness centrality were calculated for the 20 most active participants and discussion threads in the network.

4.4.2. Interaction analysis

In order to analyze the content of messages in the different discussion threads, we used a version of IA (Jordan & Henderson, 1995), where we looked at log data in discussion threads. Thus, we applied the idea of IA to focus on turn taking in connection with exchanged textual messages in the online community, along the lines suggested by Arnseth (2004). The online setting precluded an analysis of language work in terms of linguistic utterances in f2f discussions and the separate analysis of artifacts through deictic references (Arnseth, 2004; Jordan & Henderson, 1995). By “interaction” we refer to one participant’s response to another utterance in the discussion thread. Artifacts are illustrated by intermediate results (screen images) produced by the online community.

The following central concepts of interaction analysis were useful for our analysis: turn taking, micro-level analysis, and structure of events. Turn taking occurs when a new post in a discussion thread responds to a previous message or initiates a new discussion, and it encompasses the whole range of behaviors through which people can contribute and participate in an “interactional exchange system” (Jordan & Henderson, 1995). Each

utterance was numbered and studied in detail and interpreted in the context of the utterances that preceded it and to what it could mean or refer to. This is a process that Jordan and Henderson (1995) refer to as “micro-level analysis.” IA also examines the temporal organization of moment-to-moment interaction, which provides context for an event with its high and low points (Jordan & Henderson, 1995). “Structure of events” is defined as “stretches of interaction that cohere in some manner that is meaningful to the participants”, which through “a chronological time provides analysts with a standardized time line for the activities” and “events always have a structure (minimally beginnings and endings)” (Jordan & Henderson, 1995), p.57. In the reproduction of discussions below, the participants’ contributions and replies are organized chronologically in order to follow the discussion as a series of events.

5. Empirical findings and discussion

In this section we present and analyze our data. First, we present the network-level data to provide an overview of all collected data. Second, our main findings are presented as a combination of the network data and the interaction data. It should be noted that the network data gives both a bird’s eye view of the whole data set and a rationale for the subsequent interaction data selection. The interaction data is presented as a set of excerpts, numbered 1–4, reproduced from the discussion threads and representing the more detailed analysis.

5.1. General network characteristics

Two types of networks can be analyzed with SNA: single-mode (actor-to-actor) networks and dual-mode (affiliation) networks (Borgatti et al., 2013). In our case, it was necessary to construct an affiliation network of the GS online community. An affiliation

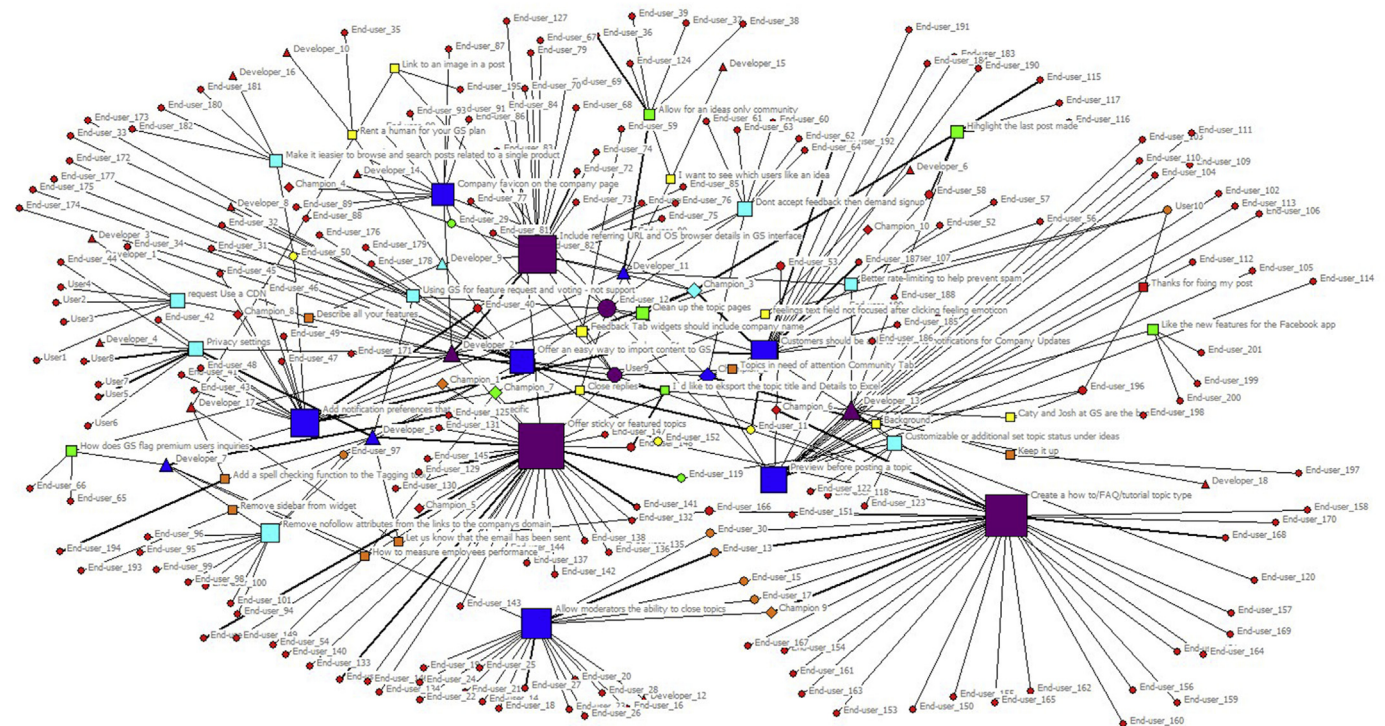


Fig. 3. Sociogram of the affiliation network of all contributors (N = 229) of “Share an idea” and “Give Praise” threads. Node size reflects degree centrality; shape reflects node type (end user: circle; developer: triangle; champion: diamond; thread: square); rainbow color range reflects betweenness centrality (red = lowest; violet = highest).

network (Breiger, 1974; Faust, 1997), defines two non-overlapping sets of nodes (actor nodes and affiliation nodes), in our case the participants and the discussions they take part in. The affiliation network is thus our most comprehensive model of the network. Fig. 3 visualizes participants and threads as differently shaped (four different shapes) colored nodes (rainbow color range) and represents the entire population of 229 users and 41 discussion threads; it also shows both degree and betweenness centrality of all network nodes. Links between two nodes do not reflect direct conversation between two persons but rather shared participation in a thread (indirect links). This implies that we assume those who contribute in the thread have read the postings to which they respond, and on that basis we create an indirect connection between the two persons (e.g. questioner and answerer).

In Fig. 3, node size indicates degree centrality, which in our case means the number of threads a person has posted to. The degree centrality of a thread is the number of participants who participate in it (with the number of postings of each contributor as a numeric qualifier). The data obtained from Fig. 3 helped us to address our research question and informed our subsequent interaction analysis by extracting the following information: 1) the most active discussion threads (thread degree centrality) and 2) the most active contributors in terms of number of postings (actor degree centrality).

We used SNA to compute degree centrality and identify the 20 most active discussion threads in the community (Table 3). Degree centrality was normalized and reported as a percentage of the maximum degree centrality a node can have (UCINET output). We included the degree centrality of a node (actor and discussion thread) and the network, the latter meaning the network's "distribution of centrality" (Borgatti et al., 2013; Hanneman & Riddle, 2005).

The network centralization of all discussion threads is 14.033 (Table 4), which means there are many discussion threads in the GS online community (a number closer to 100 would indicate fewer and larger threads) (Scott, 2001). We selected the following three threads for subsequent interaction analysis: 1) "Create a How To/FAQ/Tutorial topic type," 2) "Offer sticky or featured topics," and 3) "Add notification preferences that are product-specific." The rationale for this selection is that the three threads all have higher degree centrality (Table 3) than the average/mean degree centrality in the network (6.824, Table 4). The chosen threads are therefore among the most active discussion threads in the online community.

Table 4

Descriptive statistics of all discussion threads. Numbers are in percentages.

All discussion threads	NrmDegree
Average/mean	6.824
Variance	21.773
Network centralization	14.033

Furthermore, the network degree centralization variance, which is 21.773, indicates that some discussion threads have more activity than others. A low variance would indicate an equal distribution of degree centrality in the network (Hanneman & Riddle, 2005). In addition to centrality measures, another criterion we used for selecting discussion threads was their relevance to our research question (i.e. do they relate to mutual development, user-driven innovation, and developer-user interactions).

Next, we converted the two-mode (affiliation) network into a single-mode actor-by-actor matrix using UCINET (Borgatti et al.,

Table 5

(Left) normalized degree centrality for the 20 most active participants in terms of selection power, and (right) normalized betweenness centrality for the most active participant in terms of control power. Numbers are in percentages.

Participant	NrmDegree	Participant	NrmBetweenness
User 9	11.307	User 9	18.399
End-user_12	10.475	Developer_13	15.434
Developer_2	8.957	End-user_12	14.870
Developer_5	8.517	Developer_2	13.820
Developer_13	8.174	Developer_7	9.157
Champion_3	7.660	Champion 2	9.112
Champion_2	6.828	Developer_5	8.009
End-user_13	6.461	Developer_11	7.085
Champion_9	5.751	Champion_3	3.998
End-user_11	5.702	Developer_9	2.750
Developer_11	5.702	End-user_29	2.681
Champion_7	5.042	Champion_7	2.188
End-user_119	4.797	End-user_152	1.769
End-user_129	4.552	End-user_119	1.651
End-user_128	4.552	End-user_11	1.617
End-user_126	4.552	Champion_1	1.484
End-user_141	4.552	End-user_50	1.408
End-user_51	4.479	End-user_17	1.379
End-user_15	4.405	End-user_13	1.379
End-user_40	4.332	End-user_15	1.379

Table 3

Freeman's degree centrality of the 20 most active discussion threads. Numbers are in percentages.

Discussion thread	NrmDegree
Include referring URL and OS browser details in GS interface	20.137
Customers should be able to opt in to notifications for Company updates	16.705
Offer an easy way to import content to GS	15.789
Offer sticky or featured topics	14.645
Clean up the topic pages	14.188
Add notification preferences that are product specific	11.556
Preview before posting a topic	11.442
Create a how to/FAQ/tutorial topic type	11.327
Close replies	9.039
Don't accept feedback then demand signup	8.810
I'd like to export the topic title and details to Excel	8.810
Highlight the last post made	8.467
Company favicon on the company page	8.467
Privacy settings	8.238
Feedback Tab widgets should include company name	7.437
Better rate-limiting to help prevent spam	7.323
Using GS for feature request and voting – not support	6.407
Remove nofollow attributes from the links to the company domain	5.950
Topics in need of attention Community Tab	5.721
Link to an image in a post	5.492

2002). This allowed us to calculate degree centrality and betweenness centrality for each actor (Freeman, 1979) and identify the most active contributors and information brokers in the network. The resulting UCINET outputs are placed next to each other in Table 5; the numbers shown are percentages. The “NrmDegree” and “NrmBetweenness” columns in Table 5 are normalized values, a percentage of the maximum centrality value one can have (a number closer to 100 in the second column would indicate a user had contributed to almost all of the discussions).

While SNA data provides useful information about the overall structure of a social network, it does not tell us anything about the quality of interactions or the content of postings. This limitation could lead to misguided interpretations of who is powerful in the network (Borgatti et al., 2002). Descending to a more detailed level of analysis and studying the content of participants' messages is one way to address this limitation. In the next section, we describe the combination of SNA and IA in order to analyze the

community. The structure of the presentation of the empirical data is as follows: First, we have a column identifying the turn in the conversation. The next column names the type of participant or actor (end user, developer, or champion) who made the statement (abbreviated E: end user; C: champion; D: developer). Then, the utterance made by the actor is presented. In order to integrate the SNA data, we added the following two columns: normalized degree centrality (abbreviated nDeg) and normalized betweenness centrality (abbreviated nBet).

5.2.1. Excerpt 1: gatekeeping

The first excerpt is from the discussion thread “Create a How To/FAQ/Tutorial topic type,” which was the eighth most active discussion thread in our data (Table 3). A champion moderates the conversation of two customers (End user 168 and End user 169), who propose slightly different solutions for a requested feature and disagree about which is the more generally applicable.

Turn	Actor	Text from discussion thread	nDeg	nBet
1	E_150	Create a How To/FAQ/Tutorial topic type. Could really use a 'knowledge base' topic where the company could post simple how-to's, screencasts etc.	2.839	0.00
2	E_151	I suppose the fact that this thread is almost 2 years old means I shouldn't hold my breath:(right now users can do one of the following: 1) ask a question 2) share an idea 3) report a problem 4) give praise. i'd like to suggest a fifth type 5) tutorial/wiki	2.839	0.00
3	C_8	We do plan to introduce this sort of topic type, but in the mean time if you have a topic that needs to be edited, let me know and I'd be happy to make the change for you.	1.371	0.00
4	D_19	Unfortunately I don't have an update for this Idea. I also really want this feature and will continue to bring it up to the team.	0.489	0.00
5	E_168	Guys, I've created a solution, which may be helpful to you, based on some of the ideas in this thread. Take a look at my community at [name of website redacted for anonymity] Note on the right under Additional support links I have an FAQ page for each of my products. B) If you click on the first link, named Events-Ticketing.com FAQs, it will take you to Community Products Events-Ticketing.com FAQs. C). Note that each entry on that page is a single question by an employee named FAQ with a little FAQ button as their photo. D)- Each answer is an Official Response, again by employee FAQ. And there you have it - A dedicated FAQ page for each of my products that my customers love. It's not a perfect solution, but it does work well.	4.185	0.00
6	D_13	This is great, end-user 168! Thank you for sharing!	8.174	15.434
7	E_168	My pleasure!	4.185	0.00
8	E_169	Instead of creating a new product for each FAQ, why not just tag each FAQ topic with a PRODUCTNAME FAQ tag? To show your FAQ you just link to a page of all tagged topics.	2.839	0.00
9	E_168	Because my products are actually separate businesses. I really don't want my software customers looking at items for my apparel customers, so simply tagging will just not cut it for me. Your mileage may vary, though.	4.185	0.00
10	E_169	I get that. We have the same problem using GS with multiple products. I replied because your approach separates your FAQs from your businesses by defining them as individual products. To avoid that I'm suggesting, a specific FAQ tag for each of your businesses/products. You can then click on a tag to show all topics with that tag and show that page as your FAQ. In the end though, it's just another way of hacking round the issue until the GS folk make proper FAQs a feature:-)	2.839	0.00
11	C_9	Good stuff, End user 168! I like it. Another way this could work, and one that has been discussed over time here and there on Get Satisfaction, would be to maybe promote a question asked by a customer to a FAQ — with the option of maybe stripping out unneeded conversation so that you could provide a really great answer to an authentically asked question. A true FAQ in a sense.	5.751	1.379
12	E_168	Hi Champion 9, yes I was doing that for a while, but it's a lot of messing around. It's easier just to copy & paste as employee FAQ, and looks more consistent that way.	4.185	0.00

content of participants' conversations in a mass collaboration context.

5.2. Analyzing interaction data and network data in combination

In this section we present four excerpts of interaction data extracted from the selected discussion threads. The labels emerged as intermediate terms while screening and classifying the data. The first excerpt illustrates the phenomenon of “gatekeeping,” the second “bridge building,” the third “general development,” and the fourth “user-user collaboration.”

The empirical excerpts are presented in sequentially enumerated tabular format (Jordan & Henderson, 1995) and extended with SNA measures regarding the participants' positions in the online

We consider this a representative instance of the interaction pattern we call “gatekeeping” in mass collaboration. It shows how champions and developers act as moderators or gatekeepers of information (and correspondingly may be unwilling to develop a requested feature). This excerpt starts out with End user 150 suggesting an idea to improve the product (a GS tool). End user 150 has a degree centrality of 2.839, indicating that the user is a very active and central participant in the thread (average degree centrality is 1.9). This person has many contributions and/or responses concentrated in a few discussion threads. At the same time, End user 150 has low betweenness centrality (0), indicating that this person is not an influential actor in the network because no other people depend on this user to access information from other discussion threads (in which case End user 150 would have had higher

betweenness centrality). The following is an illustrative comparison: In an infectious disease activation network, End user 150 would not be a powerful node because he cannot spread the disease to other people (because he has a betweenness degree of 0).

Responding to turn 1, End user 151 (turn 2) underlines that the development process has taken two years, revealing that gatekeeping can span a long time. Looking at the SNA data, we see that End user 151 has exactly the same degree and betweenness centrality as End user 150.

Champion 8 in turn 3 replies that GS is planning to introduce the possibility for including tutorials as topic type and by reassuring that he can help edit a topic, underscoring his assigned role as a champion, possibly with the ambition to become a gatekeeper and moderator of this process. The SNA data tells us that Champion 8 has a degree centrality of 1.371, which is below the average of 1.9, but he reveals that he has skills in making modifications (turn 3: "I'd be happy to make the change for you.>").

Six months later, in turn 4, Developer 19 tells the community that he does not have an update for the idea proposal because the product team has not yet approved it. This utterance shows that Developer 19 is in a position to act as an intermediary between the user community and the developer team, or in other words as a gatekeeper or moderator of information, deciding what information to pass on and how to act on it. However, Developer 19 could be new in this role because his centrality measures are low. The statement issued in turn 4, stating he "will continue to bring it up to the team," indicates that he may not yet be on the developer team and does not have power to make any decisions. As a result, End user 168 (turn 5) replies that he has created a solution on his own and provides a web link to it.

Developer 13 acknowledges the solution and replies with gratitude, noting that this is great work. What is interesting here is that Developer 13 has very high betweenness centrality (15.434), the second highest in the GS community, which means that this person is a very central actor and contributes in many discussion threads. When such a prominent person is positive about the idea proposed by End user 168, we can interpret from our SNA data that this is important information and an effective solution. However, in SNA, "a high betweenness node" reflects the ability to threaten or stop transmitting information across the network, making communicating nodes use less efficient paths to reach one another (Borgatti et al., 2013). Looking at the IA data in isolation would not show this, as the textual message exchange demonstrates a positive response. The SNA data thus brings additional information about how to interpret the message (in this case, the power to control information by choosing to share or not share an effective solution with

other developers).

As the conversation continues, the structure of events revolves around two end users (End user 168 and End user 169) exchanging ideas about two different solutions for implementing the originally suggested feature (turns 8–10). This exchange is interrupted by Champion 9, who selectively chooses End user 168's proposal and suggests another way for it to be developed (turn 11). End user 168 later responds that Champion 9's solution led to "a lot of messing around," and thus he found his own "brute force" solution easier to implement.

Comparison to related work. From an IA perspective, gatekeeping is exemplified as a bracket of interaction where several champions and developers participate in a discussion thread, suggesting ideas and improvements for how to develop a feature requested by one or more end users, without resulting in the implementation of a developer-suggested solution. The information provided by the champions and developers sometimes indicates control over (through moderating or hindering) the free flow of information in the network. For example, Champion 9 writes, "Good stuff, End user 168! I like it. Another way this could work is ..." (turn 11) without bringing the proposal forward to the developer team.

Our claim that sometimes champions and developers are controlling information in the community is substantiated by our SNA data through degree and betweenness centrality measures. The betweenness centrality values are especially pertinent here (especially of Developer 13 and Champion 9, to a lesser extent), implying the control of information flows through the network, referred to in the SNA literature as a toll-taking role (Borgatti et al., 2013). Developer 13's utterance in turn 6 is significant in this regard. This person is strategically positioned in the network (central for information flow by participating in multiple threads with potentially interesting ideas) and contributes here with a short remark, which turns out to have big impact on the conversation. Borgatti et al. (2013, p 175.) explain this behavior as follows: "Nodes with high betweenness are in a position to threaten the network with disruption to operations or in a position to distort data or information."

5.2.2. Excerpt 2: bridge building

The extract below is from the discussion thread "Offer sticky or featured topics," which in its full length contains 57 postings by 44 participants (the longest thread in the community). The extract includes the beginning of the thread and involves two end users, three champions, and one developer. "Sticky" refers to threads that are considered important and appear before others in discussion forums.

Turn	Actor	Text from discussion thread	nDeg	nBet
1	E_125	Offer sticky or featured topics	3.084	0.00
2	D_5	Hi, End user 125, You can make a reply "sticky" but we don't currently have a mechanism for making a post sticky. If you're a company rep you can use the "Company Update" topic type to post that topic on your company home page, which might partially solve the issue for you. Can you describe your need a bit more?	8.157	8.009
3	E_125	I am a company rep in GS and we got this question from our users a couple of times. They see a post (be it a question or an idea shared), and they suggest making the thread/post sticky. And I just wanted to see if there is a way in GS to do so. Thanks for your reply. I will look into your suggestion.	3.084	0.00
4	C_1	Just got a similar request from one of our users. http://getsatisfaction.com/izea/topic...	1.713	1.484
5	C_7	I've shared this with the product team - I'm working on pulling together a community-manager focused release to help get some of these ideas and bugs all bundled together for maximum awesomeness. Stay tuned.;	5.042	2.188
6	E_131	Any progress on sticky topics?	3.084	0.00
7	C_7	We're getting closer, but it's a tough change! I'll update over here once we've rolled it out	5.042	2.188
8	C_2	I do think there is room for a "sticky" if we just arrange things a little and have them on the left side bar or the right side bar maybe in a smaller text. FAQ would be ideal. I did a very quick and rough example here but you get my drift lol	6.828	9.112

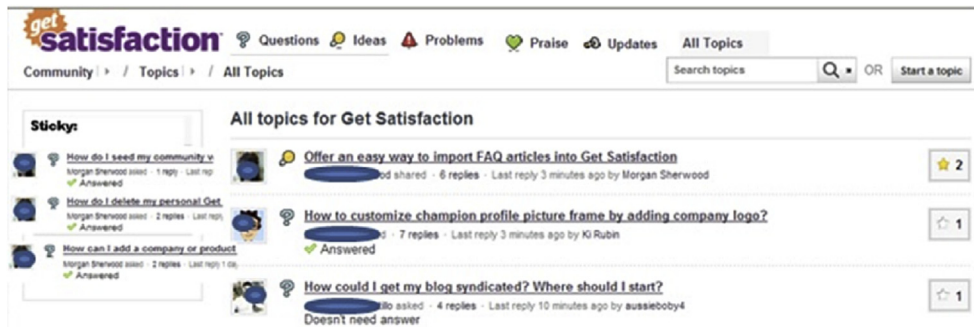


Fig. 4. A solution to a problem created by Champion 2.

In excerpt 2, champions (and sometimes professional developers) participate in an interaction pattern we call “bridge building.” Bridge building at the interaction level can be characterized by stating something in the discussion thread that can be interpreted as providing links or bridges to previous or later utterances; it thus serves to integrate participants in the discussion. The SNA data shows that End user 125, who initiated the thread, is a very active participant in the GS community. End user 125's degree centrality is 3.084, which is higher than the average (1.9, but not among the top 20, see Table 5). Developer 5 responds by suggesting a solution that “might partially solve the issue” (turn 2). In this way Developer 5 takes on a bridge building role, mediating between the customer (End user 125) and the developer team. The response is centered around answering whether or not the requested feature is planned or not. In this capacity, Developer 5 acts as a broker of information and tries to help End user 125 find a solution. The claim that developer 5 acts as a bridge builder is supported by the SNA data by showing a very high degree centrality (8.157), ranking this person among the top four most active participants in the community (see Table 5). In addition, Developer 5 also has high betweenness centrality (8.009), among the top seven participants in the network (Table 5), meaning this person is strategically positioned to make decisions and contributes to important discussion threads (see Fig. 3).

End user 125, who initiated the “sticky or featured topics” thread responds to Developer 5's question “Can you describe your need a bit more?” (Turn 3) by describing the problem and how he would like the feature to be developed. Then, Champion 1 writes that other users have requested the same feature in the past, thus providing additional justification for the request and putting some pressure on the developers to find a solution. Champion 1's degree centrality is slightly lower than the average (1.713), and his betweenness degree is above average (1.484, average of 0.55). Thus, Champion 1 is strategically located to spread or alternatively curtail information flow.

In turn 5, Champion 7 states that he has shared the idea with the product team, which indicates this may be an issue developers are working on. Champion 7 is an influential person in the community with both high degree and betweenness values (5.042 and 2.188, respectively). Champion 7 is thus both very active as poster and/or responder and can reach many participants in the network in few steps. Champion 7 is therefore in a position to pass valuable information to the developer team.

In turn 6, End user 131 asks for progress on “sticky topics.” There are two responses, one by Champion 7 and one by Champion 2. Champion 7 writes that it is a “tough change” and reiterates the sentiment in turn 5, stating, “I'll update over here once we've rolled

it out,” which indicates it could take some time. Then, Champion 2 enters the discussion. Champion 2 is the most powerful champion in the network according to centrality measures. He has very high degree centrality (6.828) and also very high betweenness centrality (9.112). In turn 8, Champion 2 proposes a solution for how to incorporate the feature in either the left or right sidebar of the user interface (Fig. 4). In this manner, Champion 2 acts as bridge builder by providing a technical solution that responds to user needs and advances the software.

Comparison to related work. There are four champions among the top 20 participants with the highest betweenness centrality (see Table 5), implying they play an important role in spreading information through the GS community. Some champions also have high degree centrality, implying they are active participants in many discussion threads. However, some of them (e.g., Champion 9) have relatively higher degree than betweenness centrality, implying their control/relay ability may not keep pace with their number of postings. By looking into the IA data for champions in excerpt 2, we can see that they relay more than they control. For example, Champion 7 states, “I've shared this with the product team ...” (turn 5). This reveals a much more active response than that of Developer 19 in excerpt 1 (turn 4) on a similar issue (“Unfortunately I don't have an update for this Idea”).

Another example of positivity and outreach in excerpt 2 is Champion 2 (turn 8) stating, “I do think there is room for a “sticky” if we just arrange things a little...” This person's bridge-building and gatekeeping capacity is supported by the SNA data, which shows that Champion 2 has very high betweenness centrality (9.992). According to Borgatti et al. (2013), “a node with high betweenness centrality means that many nodes need that node to reach other nodes via efficient paths.” Because many other participants need Champion 2 to reaching one another (e.g., end users to developers), Champion 2 has a lot of power to spread or block information quickly. However, whether or not Champion 2 does this or that cannot be gleaned by the SNA data. We needed IA, corroborated by the first author's reading the entire list of message exchanges, including those that preceded and followed the utterances presented here.

5.2.3. Excerpt 3: general development

Excerpt 3 is an extract of the discussion thread “Add notification preferences that are product specific,” where a champion shares an idea for how to improve the product. This excerpt suggests a “path” from a user-requested feature to general (developer-organized) implementation of the feature by the company and the shared integration of the feature into the product (the online GS community software).

Turn	Actor	Text from discussion thread	nDeg	nBet
1	C_1	Add notification preferences that are product specific. Allow notification preferences for topics in a particular product, rather than all topics from a company. or topics in a particular product, rather than all topics from a company. Like this: see picture: [reproduced in Fig. 1]	3.793	1.484
2	D_11	I agree, champion 1. We have this as a planned feature, along with email digests for both whole community and specific products.	5.702	7.085
3	E_41	You know what else would be pretty awesome and not hard to do? If the emails had the product name in the subject so I could at least set up mail filters.	0.710	0.00
4	E_40	Please please please... this has been in progress for over 3 years! Come on guys... this is seriously limiting our organizations adoption of Get Satisfaction.	4.332	0.864
5	E_42	I like End user 40s idea. That feature would really make my life easier!!!	1.371	0.00
6	E_43	Yes please!		
7	C_7	I'm grateful for the suggestion! I've got this idea loaded up into our feature request queue, and I'll update all y'all once I know a bit more.	5.042	2.188
8	E_40	Hey, Champion 7, is there any update on getting product specific notifications into the product?	4.332	0.864
9	C_7	I'm checking in on the status of this one - I like this idea, too, but I'm not sure how complex/expensive it gets when it comes to our email system. I'll let y'all know when I know more.	5.042	2.188
10	E_44	We have numerous products and they all arrive as emails to "Highway Records" - it'd be great if there was some differential based on what product the feedback pertained to. Even changing the line within the body of the email where it says: "End user 44 just shared this idea in Highway Records:" for instance to say "End user 44 just shared this idea in Highway Records about this product: [name of product redacted for anonymity]" I could then easily set up filtering rules in Gmail (where I catch all these emails) to forward them through to other people in my organization. It's worth noting that you already do this with respect to private feedback (i.e. it states which product the feedback was in relation to) so it would seem like a super simple thing for you guys to add to the regular, non-private email alerts	0.710	0.00
11	E_45	In our organization, different people are responsible for each product and/or service listed in our Get Satisfaction installation. As the local GS admin, I'm happy to receive all notifications but the people who look after each product have often asked me if they can limit their notifications to just the product they are responsible for. I eagerly await the development!	0.710	0.00
12	E_40	Developer 11 and Developer 12; any update on the progress of this?	4.332	0.864
13	C_8	It looks like this feature is bundled into our notification improvements, but sadly I don't have an exact time frame for when this get released.	1.371	0.00
14	D_7	I'm thankful that everyone has been so patient while we worked on other stuff): Hi everyone, I'm really glad to say that we finally launched a Product follow feature. Learn more about it on our blog: url: http://product.getsatisfaction.com/2011/07/follow-products-on-get-satisfaction	3.206	9.157

The proposal for a new feature by Champion 1 in turn 1 is responded to by Developer 11 in turn 2, who says that the feature is already planned. Developer 11 has the highest degree and betweenness centrality in this discussion thread (5.702 and 7.085, respectively), which means that this is the most active and influential participant in the thread and that this person is also involved in several other discussion threads. This person sponsoring your idea would normally be a good sign for an end user or champion. Multiple requests are also made by other end users (turns 4–9). Champion 7 intervenes in turn 7 reporting the status of a feature ("I've got this idea loaded up into our feature request queue"), but in turn 9 this champion indicates uncertainty around the time it will take to implement it based on its complexity ("I'll update all y'all once I know a bit more"). The thread spans several years. Multiple end users ask about the status of the promised implementation (End users 40, 44, 45). End user 40 complains in turn 4 that the feature request has been in progress for over three years, implying a long-term development process. This end user is 20th in terms of degree centrality (4.322, Table 5), throughout the whole network, indicating that the user is very active with many posts in the GS community. Other end users continue to post messages (turns 10–12) emphasizing how important is for them to get the feature developed (End user 45 in turn 11 writes, "I eagerly await the development!"). Champion 8 (turn 17) notes that the idea is in the developer team's pipeline but cannot provide a fixed date for its realization. Finally, Developer 7 (turn 14) announces that the requested feature has been developed and launched as part of the product. A screenshot of the new feature in a beta release of the product is shown in Fig. 5. This version derives from the product blog empowered by Get Satisfaction and consists of two pictures representing two different ways the new feature has been integrated.

Taking into account the structural information provided by Developer 7 in turn 14, we have a richer understanding of this person's role in the general development interaction pattern. Developer 7's degree centrality (3.206) indicate that he is a very central participant in the network with a lot of postings and/or responses to his postings. His high betweenness centrality (9.157), well above the average of 0.55, indicates that this person is one of the most powerful (top 5) participants in the network regarding the channeling and/or curtailing of information.

Two developers in this thread are powerful actors that contribute at different intervals (about three years apart) to inform participants about a planned feature in the beginning of the thread (Developer 11) and to conclude its realization at the end of the thread (Developer 7). Their actions, albeit brief, are significant for realizing "general development." Excerpt 3 thus illustrates software development as a collaborative effort between less technically skilled end users (customers) and technically skilled developers (employees), brokered by informed end users (champions).

Comparison to related work. When a champion in excerpt 3 requests a new feature and a developer responds after several years by stating that the feature has been developed and integrated in the product ("launched a Product follow feature"), end-user development (Fischer, 2009) appears as part of a bigger eco-system (Pollock, Williams, & D'Adderio, 2007). It shows a software artifact that has passed through a "double loop" modification process (outside → inside), incorporating both local adaptation (outside) and integration of the adaptation into the product (inside). This is an extension of an earlier version of the model of mutual development (Andersen & Mørch, 2009; Mørch & Andersen, 2010), now considering it from the perspective of mass collaboration. Progressing from a feature created by an end user to a new version of a commercial (GS) tool is tension laden and can be viewed as a

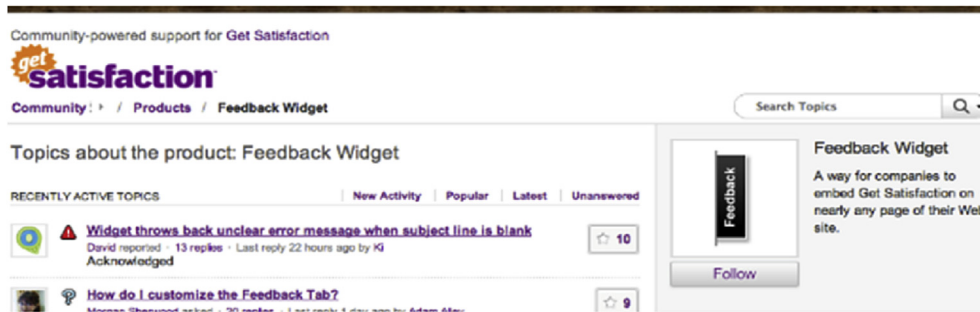


Fig. 5. A screenshot of a new feature integrated on the right hand side of the screen (Feedback Widget), here shown in a beta release of the product.

strategy for developing products that embody characteristics relevant to many users, referred to as “generification work” (Pollock et al., 2007). Generification work has technical and managerial elements, and Pollock and colleagues focus mainly on the managerial elements, from a science and technology studies (STS) perspective (i.e. asking different research questions and employing different

5.2.4. Excerpt 4: user-user collaboration

In excerpt 4, the discussion centers on the collaboration of two end users in the online community to develop a local adaptation or end-user developed solution to a previously requested (and unresolved) feature. This excerpt is extracted from the middle of the same discussion thread as excerpt 3 (general development).

Turn	Actor	Text from discussion thread	nDeg	nBet
1	E_49	Hi all I've been wanting this feature for a while now, and still do. However there is one important thing to bear in mind that I've learnt with our profile (blue ski). It relies on customers correctly categorizing topics in the first place, and that's if they bother categorizing at all, which many don't. So while it will still be a huge help, we can't rely on it completely and still need people monitoring and distributing topics	1.371	0.00
2	E_40	This may not help, depending on how you've set up your website, but you can hard-code a specific product using the embed code customization. Our “products” correlate to different websites across our properties, so we're able to use the embed code very effectively to categorize support requests to the appropriate product. However once that is done of course we still have ALL our staff getting the notifications, so it's highly frustrating.	4.332	0.864
3	E_49	Our “products” aren't that clean cut unfortunately as they revolve around the elements of a package holiday. Your suggestion got me thinking about another challenge I have though. Do you know if tags can be hard coded using the embed customization?	1.371	0.00
4	E_40	I just looked at the widget customization screen, and yes it does look like you can hard code tags. Maybe that helps	4.332	0.864
5	E_49	Brilliant! I always assumed that tag would filter the initial suggestions. Didn't realize it pre-populated the new topic. Problem solved! Thanks:)	1.371	0.00

methods than we do).

The extended model of mutual development proposed here shares traits with the private-collective model of innovation suggested by Von Hippel and Von Krogh (2003). The two models share a focus on coordinating the activities of multiple stakeholders for the sake of collaboration for a common purpose, in our case further development of a software artifact. Examples of this can be seen in turn 10 where End user 44 elaborates on a solution he has created based on an unresolved feature request in the online community. The two models also share the integration of two levels of activity, in our case local adaptation (end-user development) and generalization (professional development) (Andersen & Mørch, 2009; Mørch & Andersen, 2010). However, these two levels differ from those of the private-collective model; transitioning between the levels in our model involves an abstraction in order to integrate the end-user suggested features (redundancy removal, filtering out bad proposals, restructuring old code, etc.), whereas the private-collective model relates to the aggregation of individuals or companies (one to many innovators). The details of the abstraction process are outside the scope of the analysis we have described here and require further methods (e.g., interviews with developers, observation of decision making among developers, involvement of management in final decision making).

This excerpt shows how two end users break away from the traditional pattern of “general development” due to disappointment that an awaited development has not been realized after several years. As a result, these two end users, 49 and 40, start to collaborate on a solution without involving developers, thus the name “user-user collaboration.” Characteristic of this type of interaction, it spans a short, intense time period (about a month), involving collaboration among a few technically skilled customers. In turn 2, End user 40 states that it is possible to “hard-code” the integration of discussions with a customer-specific product by using the embed code customization functionality. This is supplemented by an example from previous use of GS software and the user's own product line. The two customers thus act as end-user developers and together collaborate on finding an ad hoc (business-specific) solution to the problem, and one of them, End user 49, implements it for his company. The two customers solve the problem on their own by “hard coding tags” to connect discussions to the products they refer to. Although not an optimal long-term solution (poor software engineering practice), it solves the problem for End user 49.

End user 49 has a degree centrality of 1.371, which indicates that this person's contributions are slightly fewer than the average contributor. The person may initiate several requests but be impatient about waiting for a developer-implemented solution and

thus wish to create his own. The user's betweenness centrality of 0 indicates he does not have the ability to exercise control over information flow. End user 40 is better positioned in the network to access information, being among the top 20 most active participants in terms of degree centrality (4.332, see Table 5) and participates in multiple threads (Fig. 3). We interpret this to mean that End user 40 can provide useful advice to End user 49 based on past interactions in other discussion threads.

Comparison to related work. User-user collaboration can be compared to collaborative tailoring, (Kahler, 2001). Collaborative end-user tailoring grows out of one or more end users' need for a feature and the happy coincidence of being in contact with another end user with a similar concern and the required technical skills to solve the problem collaboratively. The data in excerpt 4 shows how two end users collaborate to tailor a common product to fit one of their needs. When end users are empowered and able to collaborate on tailoring a certain technical complexity, in this situation by "hard coding tags by using the embed code customization" (turn 2), this can be seen as an example of objectification (Kahler, 2001), meaning that the users or moderators of a software are able to modify or change aspects of it in use. Based on the interactions of these end users, we can infer that this is possible with the GS tools. Furthermore, as excerpt 4 is extracted from the middle of a large discussion thread, it is accessible to the entire support community. This has some similarities to Kahler's (2001) emphasis on the importance of providing awareness of tailoring activities to others in the community. Despite similarities between user-user collaboration and collaborative tailoring, our work differs in that we have studied tailoring in a mass collaboration context rather than in small-group settings (Kahler, 2001). Moreover, we integrate user-user collaboration (a type of end-user development) with professional development (Andersen & Mørch, 2013).

6. Summary and conclusions

The research question prompting our research is: "What are the patterns of interaction between end users and professional developers in a mass collaboration community, as seen from a mutual development perspective?" Our data show that in mutual development of the Get Satisfaction social media platform different constellations of, end users, champions, and developers emerge who together create mutually beneficial software in joint processes of mass collaboration. The processes we studied can be seen as examples of how human behavior on a large scale is expressed through a social media technology. Our main finding is the four patterns of mass collaboration in mutual development, representing different relationships or types of interactions between end users, champions, and developers. They were named as follows during the categorization of data:

- *Gatekeeping:* This refers to an actor controlling information by filtering and/or selectively choosing what information to pass on. A gatekeeper demonstrates power by controlling the flow of information in the network in two possible ways: 1) shielding other actors from unnecessary (e.g., obscure, distracting) information and 2) withholding important information (e.g., a suggestion by an end user might go unnoticed, despite having the potential to be novel and interesting).
- *Bridge building:* A bridge builder is a "gatekeeper" who distributes (rather than withholds) information. An advantage of this role is providing other actors with timely access to information in the network; a disadvantage is that information passed on by a bridge builder could generate information overload and worst-case be disrupting to other actors' primary work.

- *General development:* This is when a local solution (hack, modification, work around, improvement request) proposed by an end user is brought to the attention of developers in the (GS) company and becomes a new feature of the "general product," in effect making improved GS tools available to all of the company's customers.
- *User-user collaboration:* Customers sometimes need to make adaptations on their own (hacks, work arounds, end-user developed solutions, etc.) to fit the software to a new use situation. In these interactions, they do so by themselves or with the help of other end users (and champions) instead of waiting for professional developers to get involved, which typically takes longer.

The four patterns reveal the following identifiable traits, or shared characteristics, of mass collaboration in mutual development:

- *Asymmetrical power relationships* (between end users, champions, and professional developers)
- *Mass collaboration in the community*, initiated mainly by end users but sometimes by champions
- *The importance of champions* for propelling user driven innovations.
- *Different time scales:* Interactions can last several years (general development) or be short, intense periods of collaboration over weeks to a few months (user-user collaboration).

We used a mixed-methods approach to analyze our data on two levels: the network level using social network analysis (SNA) and the content level using interaction analysis (IA). This combination gave us both a broad picture and a more detailed look at mass collaboration in an online community. In total, this combination gave us a fuller understanding of mass collaboration that either method could by itself. When performing SNA analysis we draw on relational data, taking the participants contributions in the GS online community as a starting point for performing the analysis. We found SNA to be a useful analytical tool for identifying powerful actors, power relations and the structural attributes of the interaction patterns. However, this was not sufficient. Therefore, we used IA to study the content of the interactions, and together the two methods complemented each other and justify the naming of the interaction patterns.

Furthermore, bringing social network data and interaction data together gave us a richer picture of the flow of information than neither method could provide by itself. In particular, SNA has contributed in the following way to guide our interaction analysis: a) We used SNA to justify our choice of interaction data for content-level analysis (choosing discussion threads based on thread degree centrality) and b) We used SNA to "tag" the different actors' utterances with network-level (socio-structural) information for informing our interaction analysis (in terms of who has power in the network, calculated by degree and betweenness values for each actor). We conclude that SNA is a valuable and useful tool for analyzing social structure in mass collaboration and especially valuable in combination with IA, but it comes at a price of mastering two very different methods for data analysis.

We extend previous research on mass collaboration in two ways: 1) we provide detailed descriptions of the distinct processes of mutual development (a specific form of mass collaboration in product development characterized by power relations and knowledge-building asymmetry), and 2) we show how the computation of two centrality measures (degree and betweenness) can identify powerful actors in a network and their different roles. This extends previous work on mass collaboration (Cress, 2013;

Halatchliyski et al., 2014; Tapscott & Williams, 2008). In previous studies, authors did not distinguish between the multiple roles of participants, except for peers and teachers, nor the distribution of power among actors. Our case involved participants playing one of three different roles (end user, champion, developer). Their centrality measures indicate two types of power in the network in terms of information flow: *selection power* for high degree actors and *control power* for high betweenness actors. When we analyzed the emerging patterns of interactions it became apparent that patterns between end users, champions, and developers were different depending on the type of software development activity they engaged in (early in the process; late in the process, etc.). In sum, our social network data and interaction data taken together provides a rich picture of the social interactions and thereby strengthening the belief of the importance of actors' ability to collaborate and determine information flow. Whereas the vast majority of participants were end users, the interaction patterns also involved champions and developers in different constellations with the end users. The following interaction patterns were identified:

- *Champions*: Champions were active in discussion threads with high degree centrality, which are the threads with many contributors. A reason for this could be that those threads are likely to attract the attention of the (GS) company because they have caught the interest of many customers. These threads may indicate discussions about functionality and the need for improvement in order for customers to continue to use GS tools. Because champions are engaged by the company to serve the customer community, they need to seek out threads that generate customer requests.
- *Champions vs. developers*: Champions participated mostly in bridge building activities by negotiating and coordinating information and technical innovations, whereas developers employed a more restrictive or administrative role, controlling information, which resembles gatekeeping.
- *Bridge building and gatekeeping*: Bridge builders were prominent among participants with high betweenness degrees, many of whom were champions (e.g., Champion 1 and Champion 2), whereas gatekeeping was associated with some developers (e.g., Developer 13 and Developer 19). Gatekeeping refers to participants controlling information by filtering and selectively choosing what to pass on. This is partly necessary and exercised by some the developers in the community in order to prioritize the many proposals for improvements received by a relatively small group of full-time developers. The champions we studied took an opposite role to that of the developers: they spread information to other actors (developers and end users) thus helping to connect developer activity with the activities of end users.

Our findings have implications for user driven innovation by identifying champions (not only lead users) as originators of ideas. Lead users are customers (end users) who are well qualified to participate in proposing new ideas along the lines suggested by lead users in user driven innovation research (Von Hippel, 2005). We found that also champions were important originators of new ideas, and their point of reference is anchored twice: a) Champions are partly paid by the company (GS), which implies a commitment to this company (e.g. brand advocates), which may cause some of their contributions to be biased, and b) champions started out as ordinary end users, representing a customer organization like a lead user (Von Hippel, 2005) or a super user (Mørch et al., 2007). Therefore, we cannot say that the innovations proposed by the participants in our study were entirely motivated by customer

needs; it is better thought of as a *compromise between two worlds*: the needs of the developers and the needs of the customers.

Our findings also have implications for CSCL by proposing an extended model of collaborative knowledge creation in situations where:

- Peer collaboration is necessary but not sufficient for sustaining and directing mass collaboration toward productive interactions → the emergence of champions as intermediaries between learners and educators
- A tangible and extensible (software) artifact is used as a shared object in collaborative knowledge creation → integrating software artifacts (in our study represented as user interfaces) with discussions about the software.

Studying mass collaboration in the mutual development of a software product has implications for traditional product development processes and innovation studies. When participants who are geographically spread around the world are enabled with tools to collaborate online, join forces, share knowledge with the purpose of co-creating a product, this may lead to new forms of online collaboration. Our work thus demonstrates how some end users have changed from consumers of finished products to active and committed contributors to processes of end-user development along the ideas proposed by Fischer (2009). These are processes of mutual development that are shaped by the needs, expectations, and skills of end users, champions, and professional developers using tools of various degree of complexity, allowing changes to be made at different levels of abstraction (from identifying problems to proposing solutions). The different social structures between the participants allowed us to identify four patterns of interaction in mass collaboration. However, further studies may be able to identify additional patterns and refine the patterns we have described. There is plenty of scope for more research in this area, as long as social media technologies continue to facilitate collaboration across boundaries of expertise, roles, and geography in online communities.

6.1. Limitations and directions for further research

The limitations of our study include the following:

- Our data was collection from mass collaboration in the development of a single software product. Further work ought to study a different product development community or a different product mediated by GS tools to see if the same interaction patterns can be identified in order to extend, verify, or adapt this work.
- We have studied software product development contributed to by end users, champions, and professional developers. This excludes managers. Managers have important decision-making functions in commercial companies and can impact the final product in many ways, for example, regarding the direction a product will develop in with the aim of increasing revenue. Our study was limited in this regard due to practical reasons. We have excluded those stakeholders who do not have an online profile in the community and who did not contribute to any of the forums. A manager might, for example, be able to exercise power and influence by tagging an idea as “not planned” and thereby shutting down an opportunity for this feature to be developed. However, those managers who also have developer status (e.g., technology managers) were included in the developer category.
- We selectively chose empirical data from two out of four types of discussion threads, “Share an idea” and “Give praise,” for

practical reasons, specifically to limit the length of the write up. It could be interesting to supplement this study with data from the categories “Report a problem” and “Ask a question.”

- SNA analysis, conducted manually by the first author, was very time-consuming as relationship data had to be hand coded one-by-one into an Excel sheet for further processing by UCINET. This was partially automated through the use of the DNA software. It is technically possible to generate sociograms and SNA analyses more directly from a social networking site, but this needs to be balanced against the privacy rights of individuals.

Directions for future studies based on the work we have presented here include but are not limited to the following questions:

- What motivates different participants to contribute to and spend much of their (leisure, without pay) time improving products belonging to a company that may profit from their work?
- How can a company ensure that large crowds of users will generate quality input and not just noise and distraction?
- How can an evolving product be prevented from becoming over-specialized or feature excessive? Is it realistic that customers can continue to request improvements of a product over the duration of its lifetime and expect to be satisfied?
- How might managers use SNA + IA type information to improve the company or organization? Understanding how customers see the product and how champions and developers solve issues could help improve fundamental business practices.

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References

- Andersen, R., & Mørch, A. I. (2009). Mutual development: A case study in customer-initiated software product development. In V. Pipek, M. B. Rosson, B. de Ruyter, & V. Wulf (Eds.), *Proceedings 2nd int'l symposium on end user development (IS-EUD 2009)*. LNCS 5435 (pp. 31–49). Berlin Heidelberg: Springer.
- Andersen, R., & Mørch, A. I. (2013). Get satisfaction: Customer engagement in collaborative software development. In *Proceedings of the 4th international symposium on end-user development (IS-EUD 2013)*. Berlin, Heidelberg: Springer-Verlag.
- Arnseth, H. C. (2004). *Discourse and artefacts in learning to argue. Analysing the practical management of computer supported collaborative learning*. University of Oslo, Faculty of Educational Sciences. PhD thesis.
- Boellstorff, T., Nardi, B., Pearce, C., & Taylor, T. L. (2012). *Ethnography and virtual worlds: A handbook of methods*. Princeton, NJ: Princeton University Press.
- Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *UCINET 6 for Windows*. Harvard: Analytic Technologies.
- Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). *Analyzing social networks*. London, UK: Sage Publications.
- Breiger, R. L. (1974). The duality of persons and groups. *Social Forces*, 53(2), 181–190.
- Cress, U. (2013). Mass collaboration and learning. In R. Luckin, P. Goodyear, B. Grabowski, S. Puntambekar, J. Underwood, & N. Winters (Eds.), *Handbook on design in educational technology* (pp. 416–425). London: Taylor and Francis.
- De Laat, M., Lally, V., Lipponen, L., & Simons, R.-J. (2007). Online teaching in networked learning communities: A multi-method approach to studying the role of the teacher. *Instructional Science*, 35(3), 257–286.
- Elliott, M. A. (2007). *Stigmergic collaboration: A theoretical framework for mass collaboration*. Centre for Ideas, Victorian College of the Arts, University of Melbourne. PhD thesis.
- Faust, L. (1997). Centrality in affiliation networks. *Social Networks*, 19, 157–191.
- Fischer, G. (2009). End-user development and meta-design: Foundations for cultures of participation. In *Proceedings second international symposium on end user development* (pp. 3–14). Berlin-Heidelberg: Springer-Verlag.
- Forté, A. (2015). The new information literate: Open collaboration and information production in schools. *Computer-Supported Collaborative Learning*, 10(1), 35–51.
- Freeman, L. C. (1979). Centrality in networks: Conceptual clarification. *Social Networks*, 1(3), 215–239.
- Fugelli, P., Lahn, L. C., & Mørch, A. I. (2013). Shared prolepsis and intersubjectivity in open source development: Expansive grounding in distributed work. In *Proceedings CSCW/2013* (pp. 129–144). New York: ACM Press.
- Get Satisfaction (2016): <https://getsatisfaction.com/corp/product/>.
- Halatchliyski, I., Moskaliuk, J., Kimmerle, J., & Cress, U. (2014). Explaining authors' contribution to pivotal artifacts during mass collaboration in the Wikipedia's knowledge base. *Computer-Supported Collaborative Learning*, 9(1), 97–115.
- Hanneman, R. A., & Riddle, M. (2005). *Introduction to social network methods*. Riverside, CA: University of California, Riverside (published in digital form at: <http://faculty.ucr.edu/~hanneman/>).
- Hine, C. (2008). Virtual ethnography: Modes, varieties, and affordances. In N. Fielding, R. M. Lee, & G. Blank (Eds.), *The SAGE handbook of online research methods* (pp. 257–270). London, UK: SAGE Publications.
- Heiskanen, E., Hyysalo, S., Kotro, T., & Repo, P. (2010). Constructing innovative users and user-inclusive innovation communities. *Technology Analysis & Strategic Management*, 22(4), 495–511.
- Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundation and practice. *The Journal of the Learning Sciences*, 4, 39–103.
- Kahler, H. (2001). *Supporting collaborative tailoring*. Denmark: Roskilde University. PhD thesis.
- King, N. (1998). Template analysis. In G. Symon, & C. Cassell (Eds.), *Qualitative methods and analysis in organizational research: A practical guide* (pp. 118–134). London, UK: SAGE Publications.
- Kozinets, R. V. (2010). *Netnography: Doing ethnographic research online*. Sage Publications.
- Leifeld, P. (2010). *Discourse network analyzer (DNA) manual*. Available at: <http://www.philipleifeld.de/discourse-network-analyzer-dna/manual>.
- Martínez, A., Dimitriadis, Y., Gómez-Sánchez, E., Rubia-Avi, B., Jorrín-Abellan, I., & Marcos, J. A. (2006). Studying participation networks in collaboration using mixed methods. *Computer-Supported Collaborative Learning*, 1, 383–408.
- Moen, A., Mørch, A. I., & Paavola, S. (2012). *Collaborative knowledge creation: Practices, tools, and concepts*. Amsterdam: The Netherlands: Sense Publishers.
- Mørch, A. I., & Andersen, R. (2010). Mutual development: The software engineering context of end-user development. *Journal of Organizational and End User Computing*, 22(2), 36–57.
- Mørch, A. I., Hansen Åsand, H.-R., & Ludvigsen, S. R. (2007). The organization of end user development in an accounting company. In S. Clarke (Ed.), *End user computing challenges and technologies: Emerging tools and applications* (pp. 102–123). Hershey, PA: Information Science Reference.
- Paavola, S., Lipponen, L., & Hakkarainen, K. (2004). Models of innovative knowledge communities and three metaphors of learning. *Review of Educational Research*, 74(4), 557–576.
- Pollock, N., Williams, R., & D'Adderio, L. (2007). Global software and its provenance: Generification work in the production of organizational software packages. *Social Studies of Science*, 37(2), 254–280.
- Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 97–118). New York: Cambridge University Press.
- Scott, J. (2001). *Social network analysis: A handbook*. Sage Publications.
- Siqin, T., van Aalst, J., & Chu, S. K. W. (2015). Fixed group and opportunistic collaboration in a CSDL environment. *Computer-Supported Collaborative Learning*, 10(2), 161–181.
- Stahl, G., Koschmann, T., & Suthers, D. D. (2006). Computer-supported collaborative learning: An historical perspective. In *Cambridge handbook of the learning sciences*, 2006.
- Tapscott, D., & Williams, A. D. (2008). *Wikinomics: How mass collaboration changes everything*. London: Atlantic Group.
- Tashakkori, A., & Teddlie, C. (2010). *Handbook of mixed methods in social and behavioral research*. London: Sage Publications. London: UK.
- Von Hippel, E. (2005). *Democratizing innovation*. MIT Press.
- Von Hippel, E., & Von Krogh, G. V. (2003). Open source software and the “private-collective” innovation model: Issues for organization science. *Organization Science*, 14(2), 209–223.