

The right tool for the wrong task? Match and mismatch between first and second stimulus in double stimulation

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Abstract Using Vygotsky's notion of double stimulation as an analytical tool, we discuss the complex relationship between tasks, tools, and agency in CSCL environments. Empirically we examine how learners in a Norwegian senior high school class learning English as a foreign language approach and respond to an open-ended and collectively oriented task using a wiki. Our findings show that collectively oriented knowledge and language production takes place locally in small groups as well as in the larger collective of the class, and that learners find it difficult to maintain awareness of both levels of activity. However, when facing a breakdown in the wiki application, learners sustained strategies that carried many of the characteristics of collective production. We argue that there is a need to further theorize the task-tool relationship in activities involving collective knowledge production and that we need to align pedagogical as well as technological designs in order to give support for such efforts.

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Introduction

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In this article we examine the relationship between a task and the tools that learners pick up, appropriate, and transform in order to make them serve their purpose. Such tools are available in the form of material artifacts, procedures for using them, and the concepts that make tools and procedures understood between and across individuals and groups. Tools are vital when identifying settings such as schools (e.g., pencils, calculators, word processors). Often they are provided by an instructor for a particular task (e.g., handouts, colored markers, proprietary software). At other times, learners pick up tools that were not initially part of the educational design and make them serve their needs. This trend has intensified over the last 10–15 years as a plethora of digital and networked cultural tools

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have made increasingly greater impact on education (e.g., Lankshear et al. 2000; Pew Internet and American Life Project 2002; Säljö 1999).

Our focus is on the relationship between the educational task and the material artifact in the form of wiki technology. The basic premise of a wiki is that anybody can contribute, revise, and delete and that any change is immediately available in a browser window for anyone to see (Leuf and Cunningham 2001). Consequently, there is a collective aspect to using wikis, which is materialized in specific wiki features (e.g., comment functions, history of revisions, and interlinking). We argue that such features may not be automatically appropriated but need to be related to the task at hand. In schools, learners face a challenge, a problem, or a task that has been designed for a particular pedagogical purpose or they face situations that are likely to appear in work and public life. In both cases the purpose of exploiting tools is for learners to respond to such diverse challenges. Tasks are also one of the teacher's most important structuring devices to give direction to learners' agency. Thus, the rationale of the present study is to examine how responses to an educational task are constructed by learners using one specific type of computer support (wiki) for collaborative learning (CSCL). Embedded in this task-tool relationship is the connection between individual contributions and the collectively oriented wiki task. We do not see the relationship between task and tool and the relationship between individual and collective production as two separate themes but rather as the latter relationship being an important dimension of the former.

From CSCL research we know that the use of computers cannot be understood by only focusing on features in the technologies or the cognitive processes that are activated when using such resources (Arnseth and Ludvigsen 2006; Stahl 2006; Strijbos et al. 2004). What emerges from numerous CSCL studies is a complex interplay between agents, artifacts, and the socio-historical context that weaves resources into a dynamic system of what could be called cultural tools. In short, a view of CSCL as emerging in cultural practices has enhanced our understanding of how learning and teaching are enacted when available resources abound. In addition, research demonstrates that collaboration of various types can be productive in particular subjects and for developing goal directed discourse, and that diverse external representations mediate such collaborative conversations (e.g. Andriessen et al. 2003; de Jong and Jules 2005; Mercer 2000; Sawyer and Berson 2004).

We argue that the use of tools is intrinsically linked to task challenges and responses. If available tools do not facilitate the disentangling of the problem at hand it is simply not relevant for participants to pick them up. This relationship is at the heart of Vygotsky's (1978) notion of double stimulation, a method for studying cognitive processes and not just results. In a school setting, typically the first stimulus would be the problem, challenge, task, or assignment to which learners are expected to respond. The second stimulus would be the available mediating tools. However, it is important to note that Vygotsky described this relationship in dynamic terms and where the second stimulus is not a discrete end point for this process but, "Rather, we simultaneously offer a *second series of stimuli* that have a special function. In this way we are able to study the process of accomplishing a task by the aid of specific auxiliary means" (p. 74, emphasis in the original). Note that Vygotsky identifies the second stimulus in the plural—a series. We take this to be most important when approaching the second stimulus in the form of digital tools.

We examine the relationship between task and tool by analyzing a class of senior high school learners (age 17) in a Norwegian school who make use of wiki technology and wiki working mode in order to respond to a broad and collectively oriented task in the subject English as a Second Language (ESL). Wikis are especially suited for studying the relationship between task and tool since they hold a potential for collaborative knowledge

construction and, thus, can be seen as a possible response to tasks that demand such competence. From this backdrop we ask the following research question:

- What role does the relationship between task (first stimulus) and cultural tool (second stimulus) play in collaborative knowledge construction?

We are in other words, interested in studying how students construct knowledge together and the resources they appropriate for this purpose. Collaborative knowledge construction refers to efforts to share and make sense, scrutinize, criticize and/or elaborate contributions from others in order to create a common object (Stahl 2006; Suthers 2006; Arvaja 2007). We pursue this question throughout this study by first discussing Vygotsky's (1978, 1986) concept of double stimulation and how it relates to the connection between task and wiki technology as well as learners' uptake of other resources. Next, we review relevant literature on task in the CSCL field and with a particular view to wikis. This is followed by an empirical study of learners' use of a wiki when faced with an open task in the school subject of ESL. In particular, we follow the trajectory of a "focus group" (the term is not restricted to the focus group interview sense) through the various stages of their wiki contributions, how they present their work to the rest of the class, and how they reflect on their experience. Finally, we discuss what the study reveals about task and tool match or mismatch and what this implies for theorizing this relationship as well as for developing productive tasks for CSCL classroom practices.

Task and tool as double stimulation

Vygotsky's (1978) notion of double stimulation is a method aimed to capture the "complex dialectical process" (p. 73) of development and not just the effect of an operation, as would be the case for behaviorism. For Vygotsky this dialectical process involves the interaction between mind and world when facing tasks beyond one's present capabilities. Vygotsky partly used everyday examples such as tying a knot around one's finger as a reminder or using an alarm clock in order to translate the need to wake up in the morning. But he also applied the double stimulation method to studying concept formation. (Vygotsky 1978, pp. 103–105). For example, nonsense words that meant nothing to the learner were assigned to specific object characteristics; *lag* for tall, large objects; *bik* for tall, flat objects; *mur* for tall, small objects; and *cev* for the small, flat ones. These characteristics were printed on the underside of objects that otherwise differed in color, so that they had to be turned in order to see the nonsense word. Such nonsense words developed into artificial concepts as the learner gradually discovered which nonsense words corresponded to which shape category. Thus, a new problem (first stimulus) is solved by the stepwise introduction to, or discovery of, object properties that mediate development of concept formation. As Valsiner and van der Veer (2000) point out, double stimulation involves stimuli-objects (problems, tasks) as well as stimuli-means (available social and material resources). This double stimulation approach led Vygotsky to conclude that the nature of development changes "from biological to sociohistorical" (Vygotsky 1978, p. 94).

Today we see how this is reflected in the increasingly sophisticated means humans employ to respond to new tasks, "making subjects masters of their own lives" (Engeström 2007, p. 363). For example, in education Engeström (ibid.) shows how elaborate cheating slips serve as a second stimulus when learners face a first stimulus in the form of an exam. In a study of child development, Portes et al. (1997) show how the notion of double stimulation can explain how children convert external means into object-oriented activity.

However, we see two problems when applying the classic version of double stimulation to situations involving collaborative technologies. The first is related to Vygotsky's conception of the second stimulus as being "neutral"; the nonsense words do not carry any cultural-historical connotations or content. In our case, we report from young learners using a wiki and, as events unfold, a series of other technological means. Although such means may appear to be content neutral (wikis, PowerPoint and chat rooms are initially empty), they hold inscriptions that point to a certain organization or activity, for example, regarding division of labor and the conventions or rules that are enacted in or around them. The implication is that we do not see such technologies as being mapped on to Vygotsky's notion of neutrality but argue that they serve to coordinate activities in specific ways as much as being mediators of meaning-making when taking on a novel task.

The second problem pertains to Vygotsky's (1978) emphasis on individual internalization. In the case of the nonsense words, they are tools for categorizing objects as well as signs internalized to support thinking and self-regulation (*ibid.*, p. 56). We find it difficult to map digital and networked technologies on to the concept of internalization and tool/sign qualities. As Säljö (2000) observes, internalization evokes notions of external (communication, use of tools) and internal (thinking) processes and serves to sustain a notion of learning as acquisition. Following Säljö (and Wertsch 1998) we adopt the Bakhtinian (1979/2000) concept of appropriation. Appropriation is a continuing process of using mental and material tools for object-oriented activity and where the situation or context and the presence of others are mutually constitutive for development. This takes us beyond the perspective of individual internalization and seems to be more aligned with the collaborative aspects at the heart of CSCL.

A second stimulus must be aligned with the first stimulus if there is to be any desired outcome. A knot around the finger may not help you wake up and an alarm clock may not help a learner solve an equation at the exam. There needs to be a match between the first and the second stimulus for them to mediate a productive response. That is not to say that mismatch is only counter-productive or that there is a pre-defined "ideal" match between stimuli. As several studies have shown us, mismatch in the form of tensions and breakdowns may shift the path of an activity or give rise to new activities (Engeström 1999). This is in line with the dialectical nature of Vygotsky's method which aimed to explain productive *change*. But when moving beyond our somewhat one-dimensional examples of auxiliary means used as reminders and into today's increasingly complex and technology-rich educational environments, we see that there is a precarious balance between the multifarious stimuli and the users' various responses. Consequently, we have in this section addressed the need to expand on Vygotsky's initial model. Complex and technology-rich environments afford multiple tools but the question that remains is which tools are actually picked up and appropriated by learners and how are they put to use for object-oriented endeavors. Vygotsky showed us how a relatively stable tool could serve as a second stimulus as its meaning changed with use over time. We argue for the need to align this principle with situations where we have a series of complex tools as a second stimulus.

In sum, we have sought to expand on Vygotsky's principle of double stimulation by adopting its principles, but tried to increase the analytical and explanatory power of this principle by addressing tasks and tools that have a collective orientation and require collective strategies including the use of a series of tools. Also, we need to examine the situative aspects of tasks (how they are interpreted and negotiated) and how cultural tools can be picked up and recontextualized across different situations and settings (Daniels 2001). The impact of institutionally organized activities (such as tasks) on learning and cognition is one of the central themes within sociocultural research today (Gallego and Cole

2001). This involves examining the interaction processes as well as the collectively generated outcome of such interactions, working modes as well as material manifestations. Digital technologies are not by their nature “neutral.” In schools they are introduced to learners within powerful institutional traditions. In line with this, we argue for the need of a sociogenetic perspective; how we come to knowledge by taking part in collective activities that evolve over time, and where language and material artifacts function as collective structural resources (Valsiner and van der Veer 2000). From this perspective, double stimulation is conceptualized in order to capture the complexity of learning and teaching in collectively oriented and technology-rich environments.

First stimulus: Task

Precisely because of the complexity that characterizes CSCL environments, the center of attention in contemporary studies of tasks has shifted from approaching the task as a controlled variable in an individual’s learning experience towards an understanding of the task as an object that needs to be interpreted and negotiated by learners. Also, a school task is not just a teacher’s personal device for structuring classroom activities and obtaining information about learners. Rather, the task is an articulation of what the educational system considers valid knowledge and how learners and teachers can be made accountable for this knowledge (Ludvigsen 2008).

Tasks are jointly (and often continuously) reconstructed by learners as they seek to translate this object into a response in the form of a material or semiotic representation (e.g., a presentation, an essay, an equation, or a table). How pupils construct knowledge in interaction within a specific setting and the resources that they appropriate implies a focus on the total process of understanding and doing the task (Newman et al. 1984). Our own studies have shown that even though a task is formulated with specific requests from the teachers it is often treated by both teachers and pupils as being open to additions and modifications (Rasmussen 2005). This ambiguity is also expressed in several other studies of school tasks. For example, Bergquist (1990) discloses how the meaning of a task relates to the ideology of the school or what she refers to as the salient goals of the task: “to perform the task in the intended way, then, requires a sensitivity to the particular meaning that the tasks have in the setting in which they are introduced” (p. 75). A somewhat similar finding from after-school clubs is presented by Cole (1996), in which he argues that “Cognitive tasks do not ‘just happen’; they are made to happen” (p. 258). Understanding how to go about a school task depends in other words on learners’ contextualization attempts. The diversity of interactions observed among learners led the researchers in this study to observe “how the goal itself may disappear, reappear, and change” (p. 267). Based on their studies they end up with the following definition: “tasks are best thought of not as fixed entities but as strategic fictions that participants use as a means of negotiating a common interpretation of the situation. (...) it is an interpersonal, public resource for coordinated action.” (p. 267).

This more general notion of how tasks are perceived also resonates with recent research on tasks in Second Language Acquisition (SLA; Coughlan and Duff 1994), the subject in the empirical study that follows. Recently, task-based learning and instruction has emerged as an important framework as researchers argue that tasks should also seek to elicit negotiation and co-construction of meaning and not just accuracy, fluency, and complexity in SLA (see Skehan 2003 for an overview). Primacy is given to interaction over transaction and to dialogic over monologic output. Also, from a sociocultural perspective language learning tasks would adopt the “real-world” type of task that Nunan (1989) portrays as

more expansive than the “pedagogic” tasks “defined in terms of what the learner will do in the classroom rather than in the outside world” (p. 6).

When faced with the increasing complexity of today’s technology-rich learning environments the situations become more demanding. A study that explored how students understand given tasks in relation to both a highly structured and an open-ended learning environment found that interpreting the task was the main activity in both cases (Rasmussen et al. 2003). This finding reminds us how much the setting and its available resources are part of the task itself. Hampel (2006) is one of the few studies that stresses the need for tasks to be appropriate to digital technologies that have “very different affordances, that is, possibilities as well as limitations, which have an impact on its use” (p. 107). Her response is to develop task design, but her design principles do not cover the collectivity and interdependence that characterize CSCL environments in general or a wiki in particular. Also, Hampel seems to adopt a somewhat technology-driven approach to the relation between task and tool; how agents actually use these tools in order to respond to the task is not an issue. We argue that by addressing the relationship between task and tool we can capture aspects of learning as an activity that have so far been under-researched. Hence, we turn to the stimulus means in the following section.

In sum, our review demonstrates that the process of understanding a task and following an instruction is not trivial. Rather, one might say that in many cases the process of understanding a task equals the process of constructing knowledge and insights (Bergquist 1990; Nespor 1987; Newman et al. 1984). In a sociocultural perspective this involves the use of cultural tools. It is then somewhat surprising that we find few analyses in CSCL research of how tasks relate to the cultural tools that are (made) available in the task settings. Consequently, we next address the second stimulus in some detail.

Second stimulus: Wiki

As mentioned in the introduction, a basic premise of a wiki is that anybody can contribute, revise, and delete and that any change is immediately available in a browser window for anyone to see (Leuf and Cunningham 2001). Thus, for a wiki to be a productive environment for learning, reciprocity and a shared goal are vital characteristics of the activities that go into it. Consequently, wikis invite tasks for which learners’ approaches and solutions require similar characteristics. Also, as learners are not restricted to using one specific technology they may draw on other tools such as search engines, chat rooms, and PowerPoint to complement the wiki activity. Thus we have a situation where the second stimulus—the stimulus means—emerges in the form of multiple available resources, as a *series* of stimuli. In the previous section we argued that this makes Vygotsky’s original method especially applicable to studies of technology-mediated learning but also needs to be developed in order to embrace complex and non-neutral tools as well as institutional and sociogenetic aspects of learning.

There are still relatively few scientific studies on the use of wikis in education (see Lund and Smørðal 2006 for a recent overview). Typically, studies often address wiki features and the type of activities that they support such as collective writing (Garza and Hern 2006; Wang et al. 2005), publication (Forte and Bruckman 2006) and encyclopedic features (Augar et al. 2004; Désilets et al. 2005). Neither these studies nor the ones that look into learning and teaching with wikis more generally (e.g., Grant 2006; Scaletta 2006) devote much space to the role of the task in a wiki.

Elsewhere (Lund 2006) we have identified this relation as vital. In a pilot project using a wiki, learners were given the following task: “Our” USA. The sparse wording was

accompanied by instructions for learners to collectively create a representation of how they perceived the USA. The assumption was that through a task–tool relationship that afforded revisions and interlinking the content would be more collective than individual. Findings showed that aims and intentions were only partially met. Learners often revised each other's language but rarely content, and links to pages made by others seemed somewhat arbitrary. What emerged was a result where individual contributions remained isolated and were never transformed into a collective whole. Also, we identified two major modes of working. On the one hand, we found that the local practices of the small groups were very productive for written contributions to the wiki. On the other hand, we found that learners had difficulties in relating to the collective, networked production as this required that learners kept a double focus of local (individual, pair, small group) and global (other contributors, whole class, distributed information) awareness.

Consequently, the pilot study was followed by a project that aimed for a more collectively oriented task in order to enforce the collective aspects of knowledge construction (Lund 2008). As the main theme in the syllabus of the second semester centered on the UK, the task was as follows: Build a typical British town. The accompanying instructions asked learners to make a wiki representation in text and pictures of this town and suggested certain categories such as location, history, business life, tourist attractions, etc. This time, there was a noticeable collective result and there was quite some interlinking and revising. Still, only a handful of learners made use of the wiki's meta features (e.g., commentaries to contributions) to critique or respond to content written by classmates. This task had a creative and narrative element that seemed to be conducive to the collective output, but a lack of technological features and pedagogic approaches (the teacher lacked a “space” in the wiki) constrained the moves between individual, pair/group, and whole class modes of working.

Based on this review and the experience from the pilot study and the British town project, we developed the following design principles for tasks as the first stimulus when collaborative technologies, and in particular wikis, serve as the second stimulus: tasks should be too complex or demanding for the individual to respond fully to, and they should also require solutions (of different kinds) that would amount to more than the sum of individual contributions (see also Stahl 2006). The implication is that the individual-collective dimensions are examined as an aspect of the task-tool relationship. In the following sections we offer a more detailed empirical analysis of the third iteration of wiki production in ESL where these principles were operationalized.

Design of wiki learning environment

The pilot study and the project presented above are part of a longitudinal intervention study at a Norwegian upper secondary school. It rests on principles of design-based research where interventions are iterative, theory-informed and aim to capture the ecology of the learning situation. Thus, we see the development of wiki design as intimately connected with the activities in which the wiki is appropriated, with the types of tasks it lends itself to, the types of assessment that can be developed, and learners' access to social and material resources.

In the school year 2006/2007 the so-called Knowledge Promotion reform (LK06) was introduced in the Norwegian system of education (Ministry of Education and Research 2006). One of the competence aims listed in the new syllabus following this reform states that learners (16- to 17-year olds) should be able to, “Produce texts with complex content using digital media” (ibid., p. 8). This is a radical aim compared to previous syllabi where

ICT competence was hardly mentioned or, if it was, appeared as an instrumental skill of searching for information or using digital dictionaries. The teacher took the LK06 requirement as the point of departure for the use of a wiki for collective writing and knowledge construction. This means that learning to handle multiple digital resources and using a wiki has a new institutional legitimacy compared to the two previous iterations described.

The MediaWiki application used in the first two iterations is basically one open space or resource, often used for encyclopedic productions. For the third iteration we chose the XWiki application (<http://www.xwiki.org/>). The XWiki affords a shared production resource with more structure in the form of spaces that can be thematically organized and interlinked, each with a number of proprietary (but also interlinked) wiki pages (see Fig. 1, below). Thus, the idea was that this wiki would better lend itself to a school class jointly developing content over time.

In addition to competence aims in the ESL syllabus and previous research on tasks and wikis, the design approach to the third iteration was inspired by *Knowledge Forum* and *Computer Supported Intentional Learning Environments* (CSILE; Bereiter 2002) and the first and second generation of *Future Learning Environments* (FLE; Muukkonen et al. 1999). Typical of these are prompts and categories inscribed in the learning environments which provide teachers and students with tools to think with and to scaffold their collaborative efforts (Scardamalia and Bereiter 1996; Wasson and Ludvigsen 2003). These designs are directed toward prompting students' engagement in a systematic effort to advance jointly constructed knowledge objects; that is, hypotheses, theories, explanations or interpretations (Scardamalia and Bereiter 1996). However, the importance of learners'

The screenshot shows the XWiki interface. At the top is a navigation bar with buttons: Edit, Show, Print, Delete, and Rename. Below this is a 'What's New' section with the heading 'keep you and your users informed of changes to the site.' It includes two bullet points: 'This page is an automatically generated list of recently changed pages.' and 'An RSS Feed provides this recent changes to RSS readers.' Below the text is a table with four columns: Page, Date, Last Author, and Copy. The table lists 15 recently changed pages. To the right of the table is a sidebar with a 'Documentation' section and a 'Blog' section. The 'Blog' section has a 'Main' category with a list of links: Mighty Gandhi, Monsoon Wedding, Monsoon Wedding!, monsoon wedding summary, Movies, Mumbai, New Delhi, Official languages in India, Polo, Recent Members, and Review of Monsoon Wedding. Below the 'Blog' section is a 'Photos' section with links to Presentations, Sandbox, India, Ask InterMedia, Language variants, ESW project, India Colony, M, British Colonies, Popular sports in the US, Popular sports, Disco, and The norwegian language. At the bottom of the sidebar is an 'Internet' section with a 100% zoom level.

Page	Date	Last Author	Copy
Literature in ESW project	2007 Apr 19 at 10:10	Morten Veel	Copy - Delete - Rights
test page in Main	2007 Apr 19 at 09:29	Andreas Lund	Copy - Delete - Rights
SnoopRenamed in Language variants	2007 Apr 19 at 09:29	Andreas Lund	Copy - Delete - Rights
OleTest in Presentations	2007 Apr 19 at 09:26	Ole Smørdal	Copy - Delete - Rights
CalendarEvent in XWiki	2007 Apr 19 at 09:23	Administrator	Copy - Delete - Rights
Music in Disco	2007 Apr 18 at 23:48	Tomas Tobiasen	Copy - Delete - Rights
american tv-shows in ESW project	2007 Apr 18 at 22:55	Nicolay Beck	Copy - Delete - Rights
English Speaking World in ESW project	2007 Apr 18 at 21:25	Herman Bull	Copy - Delete - Rights
Disco dance in Disco	2007 Apr 18 at 18:36	Cecilia Hagen	Copy - Delete - Rights
Indian language in Main	2007 Apr 18 at 16:54	Johan Didrik Biemann Wahi	Copy - Delete - Rights
discoteques in Disco	2007 Apr 18 at 16:17	Cecilia Hagen	Copy - Delete - Rights
tutorial presentation in Presentations	2007 Apr 18 at 11:24	Andreas Lund	Copy - Delete - Rights
cha cha in Disco	2007 Apr 17 at 18:37	Cecilia Hagen	Copy - Delete - Rights
the hustle in Disco	2007 Apr 17 at 18:22	Cecilia Hagen	Copy - Delete - Rights
Movies in Main	2007 Apr 16 at 20:35	Anna Heger	Copy - Delete - Rights
DiscoFashion in Disco	2007 Apr 16 at 16:54	Emil Wik	Copy - Delete - Rights

Fig. 1 The XWiki environment showing an overview over recently changed pages, spaces (top, right hand margin), and accompanying pages (bottom, right hand margin)

ongoing interpretation, negotiation, and execution of the task is not explicitly addressed. These studies seem to overlook the fact that a vital part of collaborative work is to mutually interpret and negotiate the meaning of a given task; that is, what to do and how to do it. As the review and our own empirical research have shown, the process of interpreting what to do and how to do it is one of the main activities when students work together in CSCL environments.

In the following empirical study we adopt this extended perspective of examining process and product when examining the task–tool relationship. We (researchers and teacher) have sought to operationalize task–tool relations in learning activities as well as their outcomes by introducing a wiki and by focusing on task design. The task that was given was intended to match the part of the curriculum that emphasizes generic language learning/production skills such as negotiation and argumentation, and not so much specialized skills related to accuracy or register. Likewise, wikis are seen as generic technologies that might be conducive to such generic skills, unlike more specialized applications that might foster, for example, extended vocabulary and grammatical precision. Consequently, we will examine the ESL task–wiki tool relationship as a potentially shared and productive space for collaborative knowledge construction.

In sum, the third iteration and moving to the XWiki application aimed to facilitate demanding learning processes when facing complex and collectively oriented tasks. The principle of double stimulation (as well as our attempt to expand on it) was thus applied to this situation. The first stimulus materialized in the form of a task assumed to be simply too large and multifarious for the individual learner. The second stimulus provided was the XWiki which afforded intensive and extensive interlinking and contributions that would need intensive and continuous alignment. In addition, learners had access to a series of digital and networked technologies (word processor, online search engines, etc.).

The task finally given was titled “How has the UK and/or the US influenced the English-speaking world?” Informed by the first two iterations we now added two regulatory sub-tasks; the first required that learners showed how their contributions related to the overall task, the other required that learners showed how their contributions related to those from their classmates. This intervention was a direct response to the need for aligning task design with affordances and with inscriptions found in the tool. The outcomes would partly be the wiki content, partly the learners’ presentations showing their work, as well as how the two sub-tasks were met. Some ideas and instructions were provided on handouts, and the teacher and the researchers gave brief introductions on the rationale and use of working with wikis.

Data, method and analytical concepts

The research team of four persons included computer scientists as well as educational researchers and the teacher of the class involved in the study. The teacher was formally added to the research team so as to ensure a more balanced approach to the intervention: including the insider/participant’s (endogenous) as well as the outsider/researcher’s (exogenous) approach (see Tabak 2004, for a discussion). Researchers and the teacher corresponded via e-mail and also met to discuss wiki tasks and designs. The class consisted of 31 learners at foundation course level in a Norwegian senior high school (16 or 17 years old). They were divided into small groups (three or four) who worked on their particular take on the task and their presentations for approximately 8 h of school work plus some work from home. Three main sources of data were taped in order to get a detailed picture of how learners approached and solved the task.

First, we videotaped and transcribed approximately 6 h of learner interactions in order to document the moment-by-moment processes of knowledge construction and wiki development. We focused on one group of learners but via field notes also tried to capture overall class activity. Secondly, to capture the learning trajectory of the focus group we traced their interactions all the way through the project, including their presentation. Immediately after the presentations we conducted semi-structured interviews with the focus group as well as a second group. The same questions were posed to both groups for the sake of comparison. The third source consists of data from artifacts such as log files from the XWiki application, the collectively produced wiki content, the PowerPoint presentations produced by the students and a handout with the task and instructions. Together these three sources of data make it possible to study the relationship between task and tool in collaborative knowledge construction (Saxe 2006). As a particular focus for this study was to examine how learners related to the collective task and to the contributions from classmates, we found this multilevel approach served the purpose of the study.

The data selected for this article reflect episodes, which constitute our unit of analysis. The episode is defined as “a coherent classroom activity centering around a particular objective or purpose” (Nystrand and Gamoran 1997, p. 35). We do not approach episodes in terms of turn-taking but rather as articulations and manifestations of stages in accumulated production. Also, we focus on where gaps emerge in such processes, that is instances of silence, disturbances, and tensions in the group work or the participants’ accounts of such. We see how such gaps are part of incremental processes where instances of crucial development take place.

There are several ways of transcribing data. Transcripts vary in their level of detail depending on the researchers’ theoretical and analytical interests. In the current study, the participants’ uses of resources and their attention towards them have influenced what is included and the level of detail in the transcripts. Furthermore, we have indicated the language in use since the students shift between Norwegian and English.

From the data corpus outlined above we have identified three distinct “episodes.” An episode is defined as “a coherent classroom activity centering around a particular objective or purpose” (Nystrand and Gamoran 1997, p. 35). First, we see learners approaching, negotiating and framing the task; secondly, learners engaging in collaborative knowledge production using the wiki; thirdly, a breakdown in the wiki application resulting in the learners abandoning the material tool, but staying with the collective work format using other available resources. These three episodes or stages in the accumulated production were used to select the excerpts analyzed in the empirical section that follows. The transcribed interactions and interviews add up to the primary data in the study. This material was analyzed as discourse that involves social as well as individual contributions (van Dijk 1997). In this type of socioculturally sensitive discourse analysis individual actions and institutional dimensions are seen as non-separable (see also Mercer 2004). Hence, in our analytic approach we take individual and social interdependency as a starting point. This is particularly important when addressing emergent practices with technology in the educational sector where historicity and tradition carry considerable impact. Our analytical aims have been to investigate the participants’ interdependency when facing a collaborative task and collectively oriented tool by focusing on what was achieved in the interaction (Linell 1998) and the shared space they developed (Stahl 2006). Juxtaposing these aims with the relation between task (first stimulus) and cultural tools (second stimulus) we need analytical concepts that can unpack processes of task-oriented tool use for collaborative knowledge construction and

development of shared objects. For these purposes we find that *appropriation* and *uptake* can guide our research:

- *Appropriation*. This originally Bakhtinian (1979/2000) concept holds dialogic and context-sensitive qualities that are not so much to the fore in Vygotsky's concept of internalization. It translates as a process of "bringing something into oneself or to make something one's own" (Wertsch 1998 p. 53). Appropriation involves borrowing from others and investing the user's intentions at the same time, and is interwoven in the social context it takes place. The concept is ripe with tensions and resistance found between the agent(s) and the object(s) of appropriation. This means that that transformation is at the heart of appropriation (Lund 2004). As such, we find the concept captures a crucial aspect of wiki working mode where the institutional history of individual problem-solving meets collective modes of working.
- *Uptake*. Appropriation can be further specified and enriched by linking it to uptake. This analytical concept accounts for what resources (both conceptual and material) are picked up, interpreted, put to use, challenged, or rejected. This concept is closely related to appropriation and enables us to take into account the responses that participants create to emerging situations. The concept further sharpens the focus of the analysis on *interdependency* across situations and between different stimuli and resources available. Consequently, uptake becomes a central analytical tool to grasp how the accumulation of different kinds of historical knowledge is brought into the present (Lemke 2000). Uptake used as an analytic concept brings to our attention what is made relevant at the moment and how this relates to previous activity. For example, Suthers (2006) identifies uptake as "acts in which one participant takes up another's contribution and does something further with it" (p. 331). What is made relevant materializes through what participants choose to pick up and further cultivate. These aspects of uptake serve to make the rather theoretical construct of appropriation more concrete and tangible. We need such specification in order to capture the selections that individuals make, the dynamics that people in interactions create, and how learning paths are formed in CSCL settings.

With their context-sensitive, interdependent, and dialectical aspects, we argue that the concepts elaborated above are particularly suitable when we analyze students' collaborative knowledge construction as a mediated endeavor in naturalistic settings, including gaps, disturbances, and incidents where activities take new directions. Appropriation and uptake are concepts that are non-deterministic while still affording analysis of the object-oriented activity.

Empirical analysis

In the following the notion of double stimulation is applied to examining the task-tool relationship and how learners exercise individual agency, how they act as a group, and how they relate to the larger collective of the class. When we make this tripartite distinction it is because we see them as empirically emerging categories from participation patterns and their division of labor. Thus, even though a pair or a group is technically a collective, we perceive this as an entity which operates at a level different from the whole class. Also, it is the focus group that through episodic activity constitutes the analytical center of attention. Consequently, whole class activity will be referred to as *collective* while *group* and *individual* activity will be used for the other two levels.

We follow learners as they approach an open task, how they respond to the requirements of collective ownership, and how they have to develop alternative strategies for collective

production when there is a breakdown in the wiki application. Our focus group consists of four learners; Anne, Cecilie, Emil, and Thomas. We follow them through three episodes as they seek to give a productive response to the task given: how the US and/or the UK have influenced the English-speaking world. These episodes show how they first approach the task, their sampling of texts and other resources, a breakdown in the XWiki application, and finally the group presentation of and their reflections on the project and ways of working collaboratively.

Approaching the task

Approaching an open task where the learning object is not explicit or fixed leaves a lot of negotiation for learners: what content material to be used, how it can be found and understood, and how it can be represented in the wiki as well as in their oral presentation. The learners first spent approximately 1 h playing with ideas and discussing possible topics pertaining to UK/US influence (and returned to such activity several times throughout the project). The substantial amount of time invested suggests that this type of effort is demanding.

The students sit around school desks in small groups (4–5), each attempting to settle on a topic that can be related to the overall task as well as topics chosen by the other groups. The teacher moves between groups in order to monitor the process, occasionally offering advice and opinion. There is no use of the XWiki at this somewhat tentative stage, but ideas are sometimes followed up by quick Google searches in order to see what the Internet can offer or how such ideas are represented online. We see a process where ‘googling’ by individuals follows immediately after group members have suggested topics, and where these actions reveal to what extent learners can find resources with potential for their approach to a task. Google emerges as a first instance of a series of second stimuli in order to negotiate the many options inherent in the task formulation.

Typical for the negotiations is the excerpt below. We have included the utterances originally in Norwegian (italics) in order to indicate how the learners struggle to keep within the subject domain of ESL. Translation from Norwegian into English is found together with comments in the right-hand column. This first excerpt is selected to illustrate the wide range of topics that the students considered for their group work and how they struggle to define what exactly constitutes the English-speaking world.

Excerpt 1

Turn	Name	Talk	Translation/comment
1	Anne	<i>Synes dere at vi skal snakke om hvordan norske ungdommer blir påvirket eller?</i>	Do you think we should talk about how young Norwegians are influenced, or?
2	Thomas	I don't know. We have to find out	
3	Anne	<i>Eller hvordan musikken—mer fokus på den. Skjønner dere hva jeg mener?</i>	Or how the music—more focus on that. Do you see what I mean?
4	Thomas	Yeah, but I don't know. I don't have an answer	
5	Anne	<i>Nei, men hva synes dere? At hva vi skal fokusere på liksom?</i>	No, but what do you think? Like, what should we focus upon? (Silence for 25 s. Group reads the handout with task and instructions)
6	Thomas	Well we can, like, talk about... if you want to we can talk about how the Iraqi war has influenced the Muslim world. So it's really like a wide specter of themes, yeah	
7	Emil	Or we can talk about something else	

- 8

Thomas

Yeah. It was just an example of how wide the topics are

(Teacher approaches the group)
- 9

Teacher

So how are you doing?
- 10

Thomas

Fine, thank you

(Hand movement with upturned palms, usually suggesting uncertainty)

The students are here struggling to find a shared focus and to develop a “thesis statement” (instructions from the teacher). Anne tries to narrow down the broad topic of youth to concentrating on music. She tries to elicit responses from her peers without much success until Thomas (6), after a long pause of the group jointly studying the task and instructions, offers the war in Iraq as a topic, just to show that the task spans a wide variety of possibilities (8). So far it would seem that the group struggles with aligning their potential contribution with the broader task but there is no indication of awareness of what classmates might discuss as possible complementary contributions. When the teacher appears, Thomas signals the group’s bewilderment by an affirmative utterance contrasted by a gesture indicating vagueness.

The interchange continues as learners and teacher discuss whether countries that are not defined as English-speaking can be included. The teacher does not give a clear response, but uses their question as an opportunity to push them:

Excerpt 2

Turn	Name	Talk	Translation/comment
11	Teacher	Why don't you just tell me that... look for information. What do we mean when we say the English speaking world? (...) Find a definition and then let me know or let the class know that we will also go beyond that. We will look at other countries outside the English speaking world (...)	(Teacher walks away)
(...)			
12	Thomas	<i>Jeg vet ikke jeg</i>	I don't really know
13	Emil	<i>Aner ikke</i>	No idea (Five seconds of silence)
14	Thomas	I hate it when you get these wide themes when you can talk about almost anything	(Said with emphasis)

The teacher aims to make use of learners’ insecurity to open up a new line of investigation and turn this into an opportunity for expanding on the initial topic. However, the group appears to be stunned by the seemingly boundless and elusive assignment. The students’ comments, the many pauses and extended periods of silence indicate that the learners face a situation where the task is not intuitively understood and which requires cognitive effort through negotiation and delimitation of possible topics. Moreover, these possible topics should, ideally, add up to the overall task of portraying UK/US influence. For this situation they do not appear to have appropriated cultural tools to overcome the difficulties.

Thomas’s affect-laden remark: “I hate it when you get these wide themes when you can talk about almost anything” (14) indicates that this is not the first time he has been struggling with an open-ended task. While Google facilitates quick raids into information repositories, this technology does not provide structure or a shared space

needed for the task. A vital element in collaborative work is to mutually interpret and negotiate the meaning of a given task. We see that the learners do not yet appropriate the wiki as an option in this endeavor. As the review and our own empirical research have shown, the process of interpreting what to do and how to do it is one of the main activities when students work together in CSCL environments. Thomas's remark comes across as a crystallization of tensions between the task at hand and the available resources; Thomas is looking for strategies that might help him and the group find a more structured approach and where "anything" is replaced by a more task specific contribution.

Finally the group returns to the topic of music. Several influential genres are touched upon (blues, rock, rap, hip-hop), and quick Internet searches produce random characteristics and lyrics. Thomas suggests disco and is immediately supported by Anne who comments that it is not likely that other groups will select this topic. Also, disco, according to the group, is a concrete topic, it is manageable, and can be linked to fashion and lifestyle in the 1970s. The group agrees and quickly settles on the following approach: "How has disco influenced Europe and the Western world during the 70s?" We see that some awareness of the whole class emerges, not in or as a result of the wiki but as a common assumption of what classmates may think. However, the linking of contributions and shared resources is not raised as a topic or an option.

Sharing, copying, and "stealing"

One way of coping with tasks is to look for contextual affordances in the form of material, social, and semiotic resources. This is a type of response that captures the Vygotskian stimulus object-stimulus means relations. In the focus group (and in others we followed less systematically) the following pattern emerged: Learners divided their task into sub-tasks and first look into Wikipedia in order to access and assess already existing material. These forays served to provide an overview of the broad topic. More or less in parallel, learners also used Google. These searches differed from the Wikipedia approach in the sense that they were more exploratory and relied more on serendipity and randomly constructed searches. As the group pursues the topic of disco culture, the Wikipedia/Google strategy would seem to produce specific content elements. For instance, when "googling," jeans terms such as "bell bottoms" and "flares" were used to find additional disco culture style features. As the meaning of the task develops, so does the uptake of cultural tools.

Whether from Wikipedia or Google hits, learners gradually started copying material they found either relevant or with potential for later use and pasted it into separate Word pages they used as some sort of temporary but collective storage for information in flux, what we in the following refer to as the "scrapbook" mode of working. The scrapbook is an indication of how learners responded to a task by taking a cultural tool mainly intended for writing and turning it into a shared repository for ideas. Through a strict division of labor participants provided information on specific sub-topics. Emil, for instance, provided a comprehensive overview of typical disco dance features.

At this stage we see an uptake of the XWiki. By deleting, re-ordering and revising material in the scrapbook, texts were entered into the relevant wiki page. Often, this was done as another copy-paste operation, which resulted in a lot of Word code messing up the wiki representation. As drafts started to appear in the wiki, learners commented upon this "sampling" (their own term) of material. However, this brought about discussions of what counts as "my" material and what is joint ownership. For example, at one point the

teacher wanted to increase the group’s awareness of the collectively (whole class) emerging work:

Excerpt 3

Turn	Name	Talk
15	Teacher	This is a place where you can all go and see what you have done and share information
16	Anne	Or they can steal

The blunt response from Anne suggests that this is a sensitive issue. She seems here to reject the usefulness of the teacher’s description of the wiki as a place where you can “see and share information” (15). Despite the curricular and institutional legacy of introducing digital tools for producing complex content we see a situation in which the collective production required by the task-tool combination appears in tension with the powerful historical practice of individual writing. A shift from individual ownership towards collective production may hold different epistemological positions and, hence, we should not expect a smooth transition. The task represents a departure from the individually written assignment learners have come to expect in schooling in two ways; it is open and ill-defined which brings about Thomas’s rejection, and it runs contrary to a practice where individual grading and, hence, competition is expected which brings about Anne’s concern. The learners’ perception of powerful institutional practices influences their approach to the task as well as to the wiki.

Moreover, studies have shown that students are often left without guidance on how to find, select, interpret, and further develop information they encounter in technology-rich learning environments (Rasmussen 2005). This is also the case in the current study. Now, the task-tool relationship pertains to learners developing content using the Word “scrapbook” to copy and paste material with potential for the large-scale XWiki outcome. The learners copy and paste to get an overview of their specified topic while at the same time being protective of their own contributions, as Ann’s utterance indicates. The introduction of a collectively oriented wiki tool did not automatically change this situation. Rather, it seemed that developing collective content as an amalgamation of individual and small-group contributions remained contradictory and unresolved at this stage. However, we see from the unfolding wiki content how the group’s contributions expand and how topics from other groups materialize (Fig. 2). Interdependency through interlinking emerges as a possibility at this point, although not fully realized.

The breakdown

During the project the XWiki proved to be somewhat unstable and on the final project day at school it tended to automatically log off learners, effectively stopping the collective content from reaching its full potential. This breakdown forced learners to abandon the use of the wiki in the last production stages and during their presentations on the following day. The result was a limited number of links between wiki contributions, which again meant that the wiki failed to fully mediate the process of collective production. Instead, learners adopted other ways of working out this part of the project and adopted other tools. The situation called for quick and powerful agency as the precarious relationship between collective task and collective tool now threatened to collapse.

In the following excerpt the group addresses the new and problematic situation. Thomas (who has increasingly emerged as the participant with more initiatives) uses his laptop

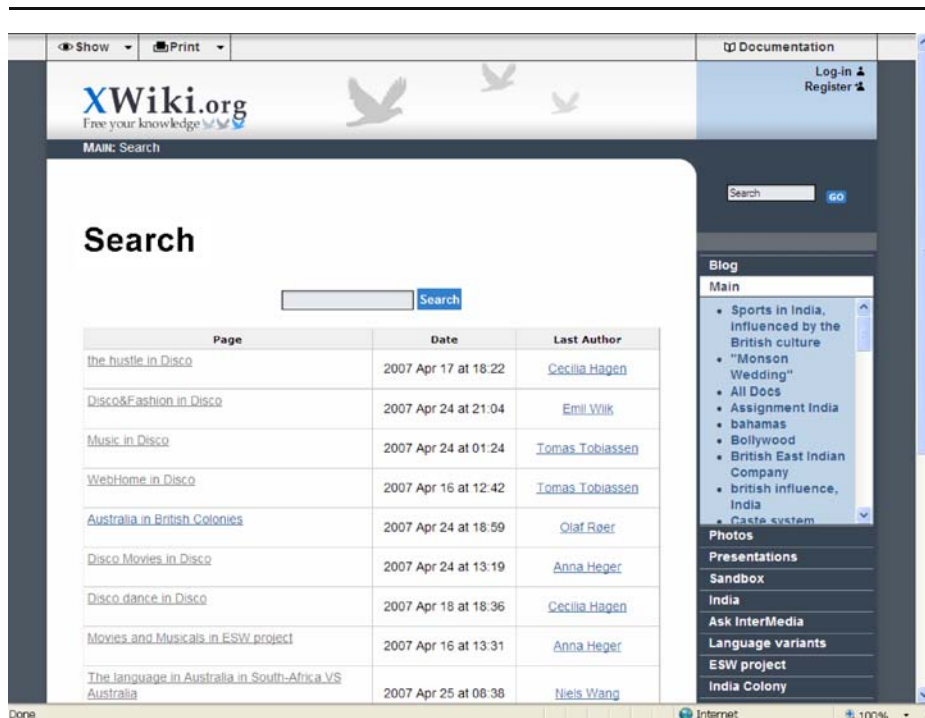


Fig. 2 A search for 'disco' in the XWiki environment showing contributions (main window). The appearance of other topics in this main window (Australia, Movies) means that they have links to the disco topic. Some other topics can be seen in the *right hand margin*

during the following exchange to illustrate the strategy he is explaining. All text is here translated from Norwegian.

Excerpt 4

Turn	Name	Talk
17	Thomas	Yes, OK—like this: I can send this one here (indexing a PowerPoint slide) around and then everyone can do as they like. Can we do it this way?
18	Cecilie	Yes. What is that?
19	Thomas	PowerPoint
20	Cecilie	Oh yes—great
21	Thomas	Because when we... I don't quite remember, but wasn't that us who worked on another project as well?
22	Cecilie	Doing what?
23	Thomas	Just passing it around so that everyone could... eh
24	Emil	Yes, you did send something to me before but I cannot seem to remember what it was
25	Thomas	Yes, I'm thinking about uni-]
26	Emil	[yes
27	Thomas	Yes because then, then it is just as if we are working in this wiki. Because everyone can do as they like and then just send it back and then pass it on again
28	Emil	And then edit each other's work
29	Thomas	Yes, that's what we in fact are doing. We can say we did it like that
30	Cecilie	Yes

Thomas suggests here using PowerPoint and to send it around the group for all to contribute freely (17). He then refers back to an earlier project where this way of working was used, asking Cecilie and Emil if it was they who worked together then. Cecilie obviously does not follow (22) while Emil states that he remembers Thomas passing something around but not what it was (24). Then, his memory is jogged by Thomas (25–27). In the interactions from 27 to 30 we see that Thomas compares his suggestion to pass the PowerPoint slides around similar to the way in which they have worked in the wiki (27). Emil immediately follows up on this, adding that they can “edit each other’s work” (28). Thomas indexes the wiki mode of reciprocal editing in turn 29. So, the group commences upon developing a jointly produced PowerPoint slide series to be used for their presentation. They only manage to draft a couple of slides before time is up while Thomas continues into the break. We see that the learners draw on collaborative practices they have developed earlier and on different technologies in order to restore the balance between task and tools, although the level of collaboration is now on the group level instead of whole class level. The breakdown enforces a reconfiguration of stimulus object and a series of stimulus means in a way not originally captured in the Vygotskian notion of a stable and neutral stimulus. The group sustains the wiki idea of interlinking and revisions but the tools adopted at this point do not fully afford whole class collaboration and this mode of work is downscaled to the group level. In the group interviews conducted immediately after the presentations, the focus group as well as a second group explicitly addressed this change of tools as a response to the revised strategy.

The episode is important since it documents a process where, in the words of Thomas, “the wiki way of working” is de-contextualized from the wiki environment and re-contextualized as well as downscaled in another setting (group members working from home) and with other available tools. It involves detaching and moving something from one context into another (Linell 1998). The group is engaged in a process of appropriation where a collective practice is adopted and adapted but is also clearly being invested in by the group. The uptake of available resources brings the rather traditional and monologic presentation tool in touch with the new mode of collective editing of a shared object. It would seem that the agency that the learners exercise in order to stay on “the wiki way of working” matches one aspect of the task; the collective presentation. Tools that may not originally hold inscriptions of collective knowledge construction are appropriated and, thus, transformed by participants.

“Wiki way of working”

During the presentations on the following day, the group jointly presents what they contributed to the XWiki as well as an assessment of the application. The 10-min presentation is backed up by a series of 14 slides. Their talk is logically structured going from aims through thesis statement, their prior knowledge, and what they needed to find out in order to accomplish their task. The seemingly trivial disco phenomenon is linked to a broader cultural Anglo-American lifestyle influence with a flamboyant character, and the group identifies its impact today, in Europe and especially in Norway. In the final section of the presentation they critique the wiki application. They mention the wiki’s potential for getting help from others and, consequently, information as well as inspiration. On one slide the following statement is made into a separate bullet point: *Look at others work and give*

help/directions. Thus, we see how learners address reciprocity in consuming as well as producing material.

However, the group also suggests improvements in the form of increased stability, faster response, and a more reliable “save” function to prevent loss of material. This observation brings them to explain how they overcame the breakdown. From previous activities this class was used to group presentations using PowerPoint while the use of SMS was strictly an out-of-school practice. We see how appropriation of substitute tools in the series of second stimuli also transforms their approach to the task. Although the wiki fails, the collective orientation is to some extent sustained. In the following, taken from the group’s presentation, Emil and Thomas explain (in English) to the rest of the class this mode of work:

Excerpt 5

Turn	Name	Talk
31	Emil	(Background: slide showing conclusion.) If we had eh... eh... had worked with XWiki... because it didn’t work out so well as we perhaps had wanted to and...
32	Thomas	[and
33	Emil	...and we think that if it worked out very well, it eh... it would be a great help, but it didn’t... so I think that we would have ended with the same results
34	Thomas	Yeah, but if it had worked better I think we could have eh... worked better together because, eh, part of the problem when you work with a group project is, it’s eh, you don’t always know how the class, other people are doing, so... if, eh, it could be more stable and we could always write everything in there, I think it would be easier to look at the overall project and see how are the other people doing, what should we do now, eh.... but...
35	Emil	Yeah, it would be, eh, I definitely think that we could have worked much faster and, and it would be easier but, eh, I have to say that our group is very happy with the results and I believe that we would have, maybe done it a bit faster with the work in XWiki but, eh, it didn’t work out, so...
36	Thomas	Yeah, and we kind of, eh, not created but we (inaudible) because we made a PowerPoint presentation at school and sent it out to everyone and everyone just added in anything they wanted to and they sent it back to me and then I just tried to put it all together, so we... and we worked on MSN to work together ‘cause we didn’t think we had enough time at school so...ah... we tried to kind of work a little bit like... we could have done with the XWiki

The slide accompanying this episode carries the group’s conclusion regarding their work process (Fig. 3).

From Excerpt 5 and from the slide in Fig. 3, we learn that the wiki did not function when the group was about to finish their work and that the breakdown made a related way of working visible; the circulation of PowerPoint slides by means of the Microsoft Service Network (MSN) chat (36). In the slide, the group refers to this as “XWiki methods” (Fig. 3). They jointly reflect upon how they de-contextualized a mode of work from the wiki environment and re-contextualized it in another setting (working from home) and with other available tools. This uptake of “XWiki methods” but with alternative tools shows us how a technology mediates specific ways of working within a context. In our case, the wiki seems to make relevant joint reflection and the creation of a shared space. We see indications of global awareness as Thomas and Emil reflect (31–36) on the missed opportunities with the XWiki. Thomas explains that if the wiki had worked, “it would be easier to look at the overall project and see how other people are doing” (34), a direct reference to the two regulatory sub-tasks concerning awareness of the global activity as

Fig. 3 The focus group’s concluding slide regarding the XWiki experience

Conclusion

- Would have ended up with the approximate same result with or without Xwiki.
- Xwiki seems untested, would have been a great tool to work with had it worked out.
- Used Xwiki “methods” by editing each others works over MSN and PowerPoint.

well as contributions from other groups. However, they do not pursue this. The potentially relevant contributions from the rest of the class are left out in their presentation. Consequently, their reference to the wiki way of working should not be interpreted as a claim for internalization but as an indication of the appropriation of cultural tools which entails that, “Expropriating it, forcing it to submit to one’s own intentions and accents, is a difficult and complicated process” (Bakhtin 2000, p. 294).

It appears that the focus group (and, as it became clear, other groups as well) worked from their homes using MSN chat to pass around the slides and comment upon their work as each group member added and revised the slide series. In a semi-structured interview immediately after the presentation, the researchers pursued this particular strategy (translated from Norwegian):

Excerpt 6

Turn	Name	Talk
37	Emil	Most of the coordination took place on, eh, MSN yesterday
38	Thomas	[MSN yesterday
39	Cecilie	[Yes, he, he
40	Anne	[In the evening
41	Researcher	Yes, that’s what the other group said as well
42	Thomas	And during the day. We started out at three o’clock and finished at 11 (...)
43	Thomas	(...) we started the first lesson by getting an overview, by trying to understand the whole project. At least I think it is important and that I—it is so much easier to work if you understand everything, you see
44	Anne	Yes. We divided the task between us and we most of it, like, during class but yesterday was, like, how to deliver
45	Emil	[Yes, that was more about collecting all the information
46	Cecilie	[Yes
47	Emil	[And also relate it what the others did in order to achieve consistency

The many overlapping turns and the fact that all group members actively take part in describing their strategy indicate that their approach to the presentation was very much a group effort. By combining the synchronous and distributed communication tool (MSN) with a dynamic repository for content development (PowerPoint) the group constructed a “wiki light” that served the immediate task at hand; to give a group presentation of a topic

and explain how they worked to get it done. Emil explains the rationale for their uptake of tools and mode of work as a way to “achieve consistency” (turn 47).

It is important to note that what the focus group described was not a single-group phenomenon. As can be seen in the following exchange another group we interviewed had used the same strategy:

Excerpt 7

Turn	Name	Talk
48	Hans	(...) we sit, like, each at his place and then... everyone writes his text and then we pass the PowerPoint around (indicates with a circular hand movement) via MSN
49	Several	[mhm
50	Hans	[and then everyone fills in their parts....
51	Several	Mhm
52	Peter	We were supposed to do this in the XWiki...

In our talks with the teacher it appeared that she was not aware of the learner strategy revealed in the presentations and elaborated through the group interviews. Thus, it would seem that learners faced with a task and the breakdown of the intended tool (XWiki) resorted to the uptake of a series of stimulus means that matched the imminent stimulus object of giving the presentation. At this point in time the presentation aspect of the task had priority over the collective and interlinked content of the wiki. In doing this learners drew on practices that they had cultivated in their lifeworlds but which apparently had not become part of the institutional repertoire.

In sum, the empirical study serves to make visible how learners respond to an open, collectively oriented task by first appropriating the wiki and, when it breaks down, reconfigure their co-working process using a series of other stimuli to match as well as to transform the task at hand. This process emerges from learner interactions, presentations and interviews. The product is the (somewhat aborted) XWiki resource, and the jointly produced and edited PowerPoint slides. However, the MSN chat afforded a distributed workspace at group level only and not for whole-class awareness. The situation enforced learner agency and involved uptake and appropriation of material resources as well as a mode of working to meet a slightly transformed task with a series of available tools.

Discussion: Implications

In the empirical study we focused on how learners picked up and appropriated available resources when facing a task that required learner interdependency for knowledge construction. We followed a process where learners sought to align their continuous interpretation of a task (stimuli-objects) and a series of tools (stimuli-means). The case indicates that the task given was of a type that was too loose and directionless for learners to find the match between a collectively oriented task and a collectively oriented tool. But before the breakdown we also registered that the XWiki application did not offer features that prompted learners to develop collective awareness beyond the group level. The wiki alone was, in other words, not enough to create the interactional accomplishment needed for collective production. This, together with the institutional heritage of schooling as an individual and often competitive endeavor, resulted in the long time spent on task orientation and negotiation as well as some resistance. We believe our analysis points to the necessity for further pedagogical and technological co-design to better facilitate awareness

of the collective effort that individuals and small groups invest in joint production. Such designs need to acknowledge the fact that a re-designed wiki may be conducive for tasks that involve a collective orientation but also that the social organization of learner–learner and learner–teacher relationships are crucial. As the review and our study indicate we need to further investigate the relationship between agents, tasks, and tools in technology-rich and collectively oriented knowledge construction in order to better support such efforts. Based on the review and our findings from the three iterations involving two different wikis we have empirically arrived at a model suggesting how diverse types of collaborative activity emerge, how these types are linked, where we see tensions and critical phases and, thus, the need for further co-development of pedagogical and technological design.

Figure 4 represents such wiki activity from task to outcome and with crucial stages in between. Tasks and their different responses in the form of approaches, activities, and possible solutions emerge as mutually constitutive of knowledge creation in a wiki; one element cannot be isolated from the other (except for analytical purposes). The model appears to be unidirectional and somewhat causal but should be read as a cyclical and iterative process where stages may not appear as discrete entities but as often overlapping and reciprocal actions. The activity cycle shows how learners worked from approaching the task, how they selected resources, divided work between themselves, and constructed drafts where often bits and pieces copied from the Internet served as raw material for getting an overview and producing draft texts.

When we relate our analysis of the current case to the above model we find that in the first phase the students struggled with narrowing the task to a topic that they could write *about*. This involved finding a manageable aspect of the larger theme. Having reconstructed and specified the task, the students then split the task into smaller parts and started searching for information separately. This was done in a way reminiscent of jigsaw learning (Aronson et al. 1978; Dillenbourg 2002). However, in jigsaw learning pieces that fit a larger whole are usually *given* to participants; in the case of the wiki task, participants had to *identify and construct* pieces that might add up to the larger picture as it developed collectively. What emerged during such processes of interpreting, constructing, and re-constructing was that the students created a group task identity; that is, they became engaged with their own group's task and not the collective product as the centre of their attention. The rest of the class remained peripheral to their local work. In Fig. 4, the two rounded boxes on the left-hand side show where learners, individually and in small groups, could develop some awareness of work by others and where they could attempt to align and coordinate their own work with that of others and the emergent wiki content. This can happen by interlinking, by revising, and sometimes by using meta-features such as a discussion space for pages. In the current case this option was abandoned at an early stage due to the breakdown. However, it can be found beyond embryonic form in the previous iterations. Our analysis shows that this type of collective orientation seems to be much more demanding than making connections at the group level. At group level learners appropriated “the wiki way of working.” The way they related this experience in presentations and interviews suggests that their zone of proximal development is extended through interdependency. The conceptual tools (their wiki “method” from Fig. 3 and “wiki way of working,” turn 27) and material tools (XWiki, and later the combination of MSN and PowerPoint—a series of stimuli) enabled them to collaboratively construct knowledge beyond the capacity of the individual.

But the exchanges we have presented show few traces of the *collective* awareness that, ideally, could be fostered using a wiki. Consequently, we see that in spite of our ambition to create a task-tool relationship that would lend itself to interdependency and a collective

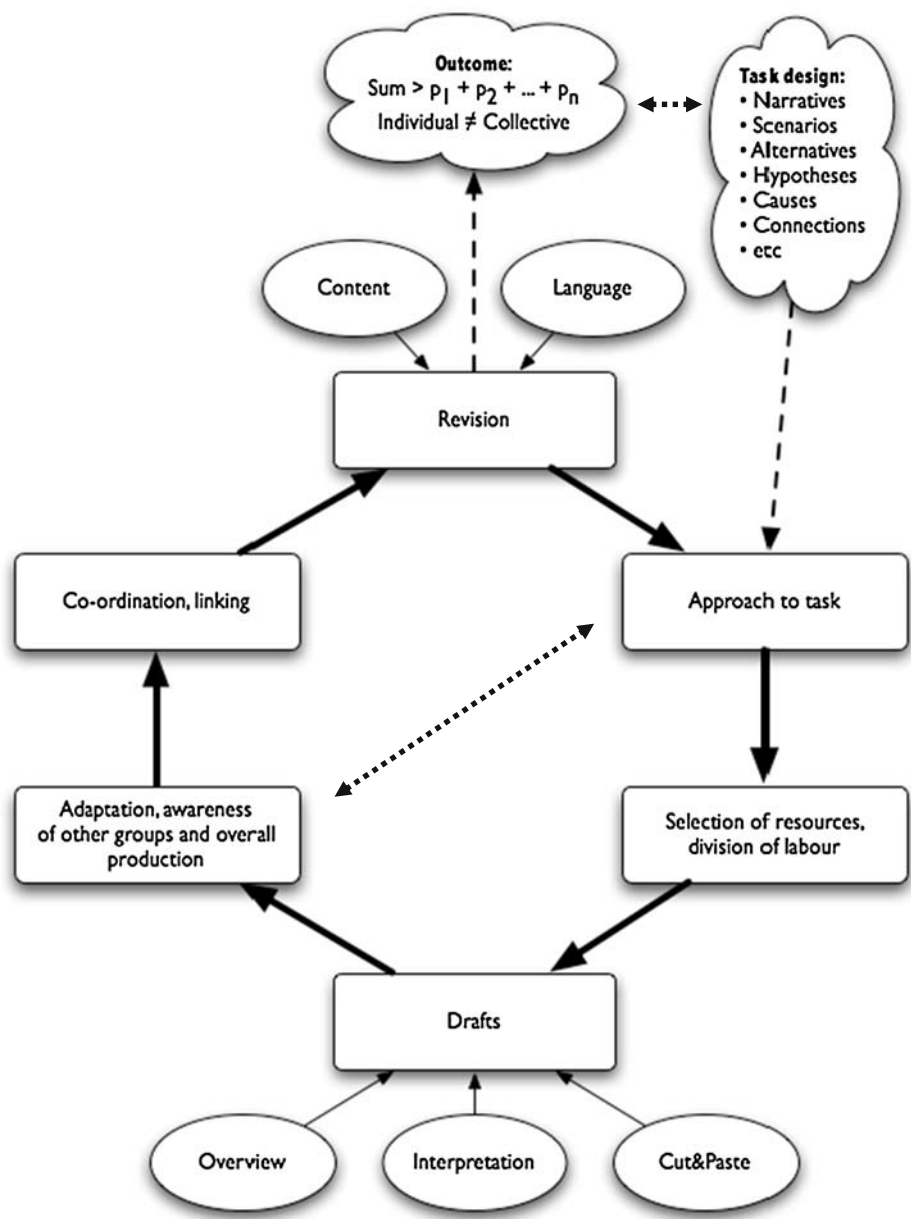


Fig. 4 Connections between tasks, activities, and tools in wiki projects

awareness already at an initial stage in the approach, learners remained at the small-group level. The learner who worried about others stealing from a shared resource emerges as a crystallization of this issue. The reasons are many, and the following is only a rough and preliminary appraisal:

Teachers lack experience in managing and participating in distributed interactions that involve individuals as well as small groups and larger collectives. To some extent, reasons

can be found in the cultural-historical conventions of schooling. An expanded repertoire is not easily achieved as such expansion involves epistemologies based on collective, interdependent production and not just individual, autonomous acquisition. As for learners, they are enculturated into an institutional history where private ownership of written material and assessment on an individual basis rule the ground (see Lund 2008, 2006; Stahl 2006). As the review revealed, tasks are cultural and social constructions and there are certain cultural conventions of approaching and solving tasks. In Norway, at any rate, task design (especially for exams) and conventional approaches have promoted independent work and not so much learner interdependency. Still, there is a tradition of open-ended tasks and collaborative group work. Learners' uptake of tools and their "wiki way of working" is, apparently, aligned with such established school practices. Finally, as we sought to align collectively oriented tasks with collectively oriented tools we found too little support for developing relationships between local and global awareness in the XWiki application. In sum, sustained pedagogical and technological co-design that is sensitive to the above issues is needed if we want CSCL to span multiple and changing configurations of collaborative activity.

Returning to the introductory research question on the relationship between first and second stimulation and its importance for collaborative knowledge construction, we can begin to formulate some assumptions and conclusions. Once again, Fig. 4 serves as a focal point of departure. We have identified primarily two stages where there is a need for further support of the learners in order for them to make the connection between local and global production.

Firstly, the horizontal and two-way dotted arrow between outcome and task design indicates where we have identified the need to design and develop tasks that involve collaborative knowledge construction in a wiki. The two connected cloud shapes at the top of the figure represent our work on task design for wiki environments. O'Neil et al. (2003) define a group task as "a task in which no single individual possesses all the resources and no single individual is likely to solve the problem or accomplish the objectives without at least some input from the others in the group" (p. 366). The line $\text{Individual} \neq \text{Collective}$ in the left-hand cloud shape captures this criterion. The line $\text{Sum} > P_1 + P_2 + \dots P_n$ symbolizes the other criterion; that the outcome of the task represents more than the sum of individual contributions. We also identify the need to develop tasks that work not at just the group level but also at the whole-class level and beyond. The cloud shape on the right-hand side suggests some task characteristics that need to be addressed in collectively oriented tools.

Secondly, the dotted two-way arrow that connects learners' approach to task with awareness of others represents a crucial aspect of work in wikis. How to give support for such awareness so that a collective working mode is established early on in the knowledge creation is a fundamental challenge. It involves not just sub-ordination but also super-ordination; that is, how the relation of a global representation relates to a particular proposition. Here we see a need for not only technical features that afford peer interaction and monitoring of collective content development but also pedagogical designs that afford opportunities for teacher intervention.

Conclusion

New technologies come with new features. In the case of wikis, they afford a more collective orientation to knowledge construction. In our wiki iterations we found this to be only partly realized and mostly on a small-group level. Our hypothesis before the third iteration was that to activate collaborative knowledge construction, tasks should be too

complex or demanding for the individual to respond fully to and they should also require solutions (of different kinds and never “terminated”) that amount to more than the mere sum of individual contributions. Our analysis of the current case shows that the task was approached, negotiated, and solved locally on a small-group level. At the same time we saw how learners through appropriation of the task as well as a series of tools transformed the second stimulus-means to serve their collaborative effort. We observed a case where learners de-contextualized a practice only to re-contextualize it as the XWiki breakdown enforced this process. That is, they stayed with the immaterial sense of the wiki, the collective orientation involved in wiki production, which materializes in specific wiki features that enable this type of collaborative work. A mode of working initially afforded by a specific technology was applied locally, not as transfer but as transformation (Linell 1998).

We argue that the findings from the current study on an empirical level make visible some of the complex relations that exist between agents, tasks, and tools in CSCL environments. We see a need to align task design with the development of technological features that boost agents’ awareness of the different levels of collectivity that are involved in joint knowledge construction so that such practices can be integrated in the repertoire of schooling. On a methodological level our contribution is found in technological and pedagogical co-design and multi-level approaches as a principle for examining activity on individual and sociogenetic levels involving small groups as well as larger collectives. Theoretically, we have extended the Vygotskian concept of double stimulation to embrace more than a neutral second stimulus on a microgenetic level. We see the need to include the tensions, affordances, and constraints that emerge between tasks and tools on a sociogenetic level. It would seem that further studies into this relationship between the stimulus object and stimulus means can advance our understanding of CSCL.

Thus, the present study demonstrates how practices give form and meaning to collaborative technologies. However, we claim that such practices can be more fully understood when we approach them in light of an extended and sociogenetic conceptualization of the double stimulation method—stimulus object and stimulus means—that Vygotsky used to examine cognitive development.

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