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Process Documentation in Sloyd: Pilot Study of the ‘Talking Tools’ Application

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Abstract—Students work in sloyd [slöjd] class represents unique areas of learning. The creative, hands-on design work, as well as a mix of both individual and collaborative processes, provide options for developing multiple skills. But these multilevel learning processes are difficult to capture. This study explores how a mobile application, the Talking Tools (TT), are used for documenting students own reflections during sloyd class. The study targets what, why, and when a group of teacher students (N=11) use TT for microblogging about their work. Their subjective reflections from a questionnaire using open-ended questions are used for validating earlier analysis of their blogs created using TT. As TT is still under development, the objective of exploring students’ documentation behaviour with the application, is to understand what the added value of TT could be for capturing various areas of learning. Suggestions for teacher guidelines for implementing TT are discussed based on the findings. The article also describes the development of the application in terms of the inter-disciplinary cooperation and collaboration. The TPACK framework is used for illustrating the know-how transcendence between collaborators in the TT application development.

Index Terms—app development, learning process, mobile documentation, mobile learning, sloyd

I. INTRODUCTION

‘Talking Tools’ (TT) is an application for mobile learning that is being developed for smartphones and tablets. It is a collaborative project between sloyd [slöjd] education researchers, transmedia developers, user experience experts, and educational technology researchers at Åbo Akademi University, Finland, as well as software developers at the UpCode Ltd. One important affordance of TT is the possibility for multimodal documentation. This design feature is grounded in sociocultural perspectives on learning [1][2][3]. The objective is to stimulate learners in multiple ways and allow them to reflect through different perspectives on their own work process: learning by watching, listening, doing, sharing, collaborating, reflecting on one’s process as a whole, as well as being exposed to variations of work processes of peers. The TT application provides a variety of features and options for usage. However, in this article we only discuss documentation affordances.

One purpose of TT is to encourage microblogging about work processes by using text and images [4]. These chronological blog entries are automatically saved in individual blogs. Peers can share their blog entries and comment on each other’s processes. The teacher can monitor the documentation, provide feedback, and share learning objects. When learners are connected via microblogging

in a virtual learning community, both teachers and students can serve as information providers, information consumers and knowledge constructors [5][6]. The assumption is that the transparency achieved through the visualisation of the sloyd process, will create opportunities for learners, peers and teachers to become more engaged in deep learning through their facilitated reflection [3][4][7].

The first context TT is tested in is a sloyd course for teacher students. Prior research on students’ sloyd process emphasizes their ability to carry out a complete sloyd process, from idea to finished product, including: planning, planning of manufacturing, manufacturing and evaluation [8]. Students are given the opportunity to define ideas, plan and carry out plans, observe consequences of activities, and evaluate different stages of the work as a whole [8][9]. However, the actual work process cannot be detected from the finished artefact in itself, and, hence, often remains hidden [10]. Moreover, the process of making a sloyd artefact takes time. The work usually stretches over several lessons, which causes inevitable interruptions in the flow of the process.

In the national core curriculum, process documentation is emphasized as an important part of sloyd education. Digital tools are encouraged to be introduced for documentation purposes already in first grade and used throughout elementary school [11]. This is where TT can bring an added value as a multimodal documentation tool. Furthermore, teaching material in sloyd education is scarce, and one idea behind TT is to fill this void [1][2].

We see it as essential, to develop teacher guidelines for how to implement learning technology [1][2]. This study is a first attempt to collect data to support such guidelines. The objective is to increase the added value of TT for the purpose of documentation for reflection. The understanding of what, why, and when students are using the microblogging tool during practical work processes will form the base for developing useful guidelines for sloyd teachers on how to implement TT in their courses. The present study includes data collected from both blog content and a questionnaire targeting students’ own reflections of using TT in their course work. The aim of this article is to discuss how the questionnaire data validate the categories found in the prior blog content analysis [2]. The analysis involves both inductive keyword coding and deductive category coding using earlier analysis of the blog data as a frame for the analysis of the questionnaire data. Finally, we discuss our understanding of the participants’ use of TT based on the comparison of the results. We highlight critical aspects of how to best implement TT as a tool for documenting creative work processes.

II. THEORETICAL PERSPECTIVES ON TALKING TOOLS DEVELOPMENT AND PILOT STUDY

Firstly, the collaboration and cooperation during the development process of TT is illustrated with the TPACK framework [12]. Secondly, we present a theoretical background for aesthetic learning processes. Thirdly, we describe the sloyd context of the pilot study. Thereafter, we present the analysis of students’ reflections on their documentation.

A. TT Development: The Importance of Knowledge Transcendence

TPACK is an acronym for *Technological Pedagogical And Content Knowledge* [12]. It is a framework (Figure 1) used for defining the kind of expert knowledge teachers need in order to apply new learning technology. We use it for illustrating the development of a mobile learning application ‘Talking Tools’ (TT) [2][13]; specifically the transcendence of knowledge needed for interface design for learning (IDL) [14]. In the following, the dimensions of the framework, listing specific expertise related to learning technology, are described in relation to our project.

Content Knowledge (CK) represents the subject matter to be taught [12]. In our case, the project started from the need to develop digital materials for teaching sloyd. The multimodal practices of sloyd do not lend themselves well to the use of computers. The environment requires mobility and flexibility. Furthermore, dust and dirt can become a safety issue when bringing computers into sloyd class. Our choice was therefore to go mobile [1][2]. Also, based on the prerogative that nearly every student in Finland owns a smartphone and many schools are investing in mobile devices. In this development project, the educators of sloyd teachers (Master’s level) represented the content knowledge. As educators and researchers, they hold *Pedagogical Knowledge* (PK), which involves both teaching methods and learning theory. These combined equals *Pedagogical Content Knowledge* (PCK); the didactic know-how about principles teachers need for teaching a specific subject [12]. In our case, this encompassed the principles that are applicable for teaching sloyd.

Technological Knowledge (TK) is referred to the ability to flexibly use technology and adapt it in relation to contextual needs [12]. In the case of TT, it further involves the know-how involved in the development process. This includes filming and editing learning objects, planning the IDL, as well as the iterative design of the IDL. *Technological Content Knowledge* (TCK) represents how technology can be used in a specific subject to enhance the content matter [12]. Here, TT, as a new tool, was visualized to bring an added value for: 1) delivering content and instructions, as well as 2) documentation of the creative learning process to be used for reflection, communication, collaboration, and assessment. *Technological Pedagogical Knowledge* (TPK) represents the knowledge about affordances and constraints inherent in learning technology solutions [12]. For this, you need both PK and TK. During the iterative design of TT, this perspective is ever present. TT has been tested on end-users (students and teachers) in several phases [2].

The continuous involvement of experts and researchers of PCK, TPK, and TK experts (programmers, designers, and user experience experts) has been crucial. Nonethe-

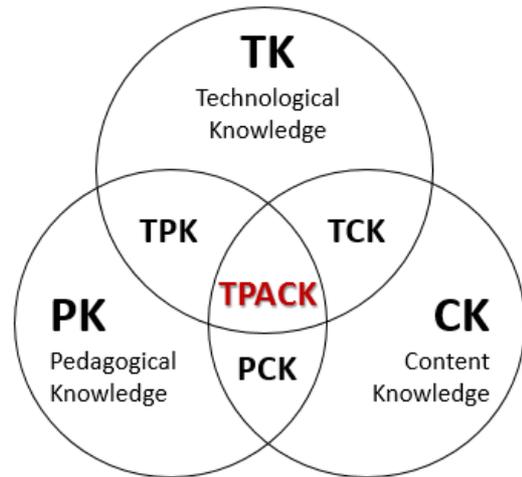


Figure 1. TPACK model adapted from [12].

less, the communication across interdisciplinary borders needs to be carefully planned and negotiated. Theoretical perspectives, values, terminology, and ways of working are dependent on each practice culture, which demands respect and understanding. Bridges for knowledge transcendence between TK and PK are essential [14], as TPK is constantly changing with the technology and the so called ‘wicked problems’ inherent in the dynamic context of learning designs [12]. This is evident in the design and development of TT as a new mobile learning application and IDL.

Finally, the *TPACK*, to be generated in our TT project, includes best practices of didactic know-how of how to use TT in sloyd education. The co-operation between end-users and experts is the backbone for our user-centered design approach. Prototypes of TT have been tested for usability, user experience, and for applicability in real life situations [2][13]. Furthermore, co-create workshop seminars are held continuously with the aim of opening up for ideas and exploration how TT can be used in various subjects. The added value can only be found in cooperation with end-users. That is, how to maximize the benefit and expand its potential for instructional use, documentation, communicating, collaborating, and assessment. But also how to expand mobile learning beyond classrooms with the use of TT. The sloyd study, presented in this article, is the first attempt to illuminate the added value of TT for documentation as one of the affordances the application can offer in a sloyd class. This is the perspective of pedagogical content knowledge (PCK) for the purpose of TPACK.

B. Theory of Aesthetic Learning Processes

We will shortly describe a theory of aesthetic learning processes in sloyd [15][16], as a frame for understanding the multiple areas of learning the documentation affordances of TT are aimed to facilitate. Figure 2 below illustrates what Lindström defines as sloyd specific types of learning. This learning typology matrix categorizes learning by four defining characters: *convergent learning* with the purpose of learning about craft techniques and tools; *divergent learning* involving knowledge gained in sloyd class that can be applied in new situations; *medium specific learning* related to sloyd specific content knowledge; and *medium neutral learning* extending beyond the subject of sloyd. These defining characters ema-

nate into the four types of learning in sloyd education identified by Lindström: 1) *learning about sloyd* includes basic content knowledge; 2) *learning in sloyd* involves the process of experimenting and achieving new goals; 3) *learning with sloyd* refers to the transfer of sloyd content knowledge into other areas outside the sloyd context; and 4) *learning through sloyd* is when the knowledge gained diverges from the sloyd context in a medium neutral way. The general competence students build can be transferred outside the sloyd context. For instance, motor skills developed in sloyd class may bring advantages in other areas of life [17].

Similarly to the matrix illustrated in Figure 2, other researchers [18] discuss learning in sloyd. However, these researchers describe a teacher and a student perspective as separate dimensions. The student perspective of possible areas of learning represents: 1) basic skills and their objectives, 2) objectives of planning and design, 3) objectives of work skills, and 4) general educational objectives. The other perspective focuses on possible areas of learning that teachers can achieve themselves through their own teaching in sloyd class. These areas are: 1) content specific skills related to the subject of sloyd, 2) the ability to plan and create didactic designs for teaching, 3) skills for implementing the plan and didactic design, and 4) teachers’ overall development as professionals.

III. THE SLOYD STUDY

The Talking Tools (TT) application was tested on eleven teacher students (seven male students and four female) taking part in a compulsory sloyd course. These were all master-level teacher students. Both first-year (N=3) and second-year (N=8) teacher students were represented. The participants were working on an assignment called ‘The Battery Guzzler’. They were challenged to design and manufacture a product that would function as a storage place for batteries. The assignment continued for six teacher-led lessons of 135 minutes each. At the beginning of the course, the participants were informed about the study and asked to participate. All ethical measures were considered. Since the mobile application at this time only supported Android devices, some of the students could use their own devices, whereas seven students were supplied with a device.

Participants were instructed to document their work process within the course, and asked to describe and reflect on their work, either during or after class. The objective was for the participants to create their own story of their sloyd process, from the first idea to the finished artefact. They were also encouraged to read each other’s blogs and give feedback. The participants documented their sloyd processes in 478 blog entries, including 273 pictures and 205 texts. They also filled in a post-questionnaire after completing the course.

The first analysis of the sloyd study, the blog content analysis [2], resulted in seven categories describing what the participants had been documenting during the sloyd course: *Concurrent Process Notes*, *Retrospective Summary Notes*, *Lecture Notes*, *Notes of Peer Activities*, *Communication with Peers*, *Emotional Comments*, and *Response to the Talking Tools App*. Here, the aim was to interpret what participants documented during their sloyd process based on the blog content. Three researchers analysed the data independently, and then the categories were compared for consistency.

	CONVERGENT	DIVERGENT
MEDIUM-SPECIFIC	learning ABOUT	learning IN
MEDIUM-NEUTRAL	learning WITH	learning THROUGH

Figure 2. Aesthetic learning processes about, in, with, and through sloyd adapted from [15][16].

IV. RESULT: POST-QUESTIONNAIRE

The questionnaire consisted of five open-ended questions guiding the participants to reflect on their documentation and describe situations when they chose to document something in their sloyd work, and further, what made them document these particular situations. The instructions of the questionnaire read as in the following: “Reflect on your own process and what you learned during the course: 1) Analyze and explain the significance the course had to (a) your own sloyd skills, (b) your own teachership in sloyd. 2) Analyze your documentation and describe situations in which you have chosen to document something in your work. What did you document in these situations? 3) What are the possibilities and limitations you see with this kind of documentation? 4) Describe your experience of using your smartphone as a support for your learning. 5) Describe your thoughts on using the smartphone as a learning tool in school.”

All eleven participants completed the post-questionnaire. The collection of data included 13 pages (5500 words in Swedish) of written text. Two approaches were used for the analysis: inductive keyword coding and deductive category coding. All excerpts have been translated from Swedish to English by the authors of this article.

A. Inductive Keyword Coding

All post-questionnaire replies were imported and categorized in the computer software Nvivo for qualitative analysis. The open-ended replies were coded *in vivo* by inductively selecting keywords of each statement [19]. This method of analysis aims to capture the essence of each sentence and facilitates further inductive categorisation. It resulted in 68 nodes (identified codes in NVivo), which were then categorised according to the questions what, why, and when. The results are presented in the following and in Table 1.

1) What They Documented:

From the inductive keyword coding of the questionnaire replies, three main themes emerged from the categorisation of what the participants had been documenting. These were product development, reflections, and technical know-how. The respondents discussed the product development as a holistic process with a focus on the step-by-step development and their own work process: “*I documented my own process, and I did it step by step (#10).*”

The change of the product was another focus, with, for instance, a before and after-perspective of the product. They also documented their mistakes or successes in their own product development. Participants further stated that they documented their own viewpoints in relation to both

practice and theory, which was interpreted as reflections: “... during the writing process you reflect and then you may find solutions to problems (#06).”

As the course objective included learning about sloyd techniques, it was not surprising that most of them mentioned technical know-how as guiding their choice of documentation. Examples mentioned by participants were: work steps, demonstrations, material, methods, techniques, tools, tips, and critical points highlighted: “...to note down things that are extra important to think about, which can easily affect the outcome... (#01).”

2) Why They Documented:

Why we do something relates to our goal-directedness, motivation and attitudes [20][21]. From the keyword coding, several reasons were found why participants microblogged during class. They were finding solutions to problems, linking theory and practice, remembering the content, and maintaining the possibility of going back to the material if they need it later on.

Attitudes play a major role for our motivation of doing something. Researchers [20] distinguish between intrinsic and extrinsic motivation. When intrinsically motivated, we do things from our own interest and joy. One example of this was expressed by one participant who wrote: “I enjoy seeing my own sloyd process (#04).” As a contrasting motivational direction, extrinsic motivation pertains to an external source for triggering our actions [20]. This was described by one participant in the following statement: “I didn’t document for myself [...] the aspects that the teacher probably wanted to hear (#09).”

Another aspect why they documented related to monitoring the work pace. One participant commented: “When I documented, it was usually because I either had succeeded with something, or that I had failed and needed a break (#05).” It seemed like the documentation was used as a legitimate excuse for taking a break. There was also a comment about TT being a facilitator for documentation. One student mentioned documenting more than usual because of having access to TT: “To document the sloyd process is important, because during the writing process you reflect and then you can come up with solutions to problems. I notice that I have documented more when I had access to Talking Tools (#06).”

3) When They Documented:

We also wanted to find out their ideas about the phase and time they chose to document something using the TT application. The time for documentation varied a great deal between participants. It included continual documentation: “It has been very useful to document continually, then I can go back to my notes and see how my process developed (#01).” Others only documented the end result, or at the end of class. To document during pauses, was another suggestion. Several said they needed reminders to document, as they said that they seemed to forget during class: “Often I forgot to document when I was working ... (#05).”

B. Deductive Category Coding

As a second approach to analysis, the questionnaire replies were coded deductively according to the seven categories found in the blog content analysis. The purpose was to see if and how the questionnaire data validated these earlier results.

TABLE I.
WHAT, WHY, AND WHEN THEY DOCUMENTED

What	Why	When
<ul style="list-style-type: none"> - Product development (<i>process, changes</i>) - Their reflections (<i>viewpoints, success, mistakes</i>) - Technical know-how (<i>steps, demonstrations, material, method, techniques, tools, tips, critical points</i>) 	<ul style="list-style-type: none"> - Finding solutions to problems - Linking theory and practice - Remembering the content - Ability to go back to the material - Motivated by seeing the work process - Documented to please the teacher - Monitoring the work pace - Because TT afforded new documentation options 	<ul style="list-style-type: none"> - Continually - End results - During pauses - When being reminded

1) Concurrent Process Notes:

The blog content analysis showed that much of the microblogging was made after the completion of a critical step of a work process, and before the next step or phase started. From the questionnaire it was evident that most of the participants found it beneficial to use the application for documenting during the sloyd process. One participant (#03) wrote in the questionnaire: “The best thing about this way of documenting was perhaps the ease of taking a photo while working, and thus be able to document all the work steps you wanted.” Another participant (#04) wrote: “I tried to document step by step by taking photos.” The possibility of easily taking photos while working was often mentioned. It was also evident that they wanted to remember difficult steps in a work process in order to be able to replicate it later on in their own work: “I documented thoroughly every new work phase, so that I will be able to build a similar artefact in a few years’ time, only by looking at my drawings and documentations (#07).”

2) Retrospective Summary Notes:

The microblogging was also used for diary-like descriptions of what had happened during class. This category contrasted Concurrent Process Notes with regard to both length of notes and the time of the documentation. From the questionnaire replies, we could see that this was discussed in terms of having forgotten to document during the process. One participant (#11) wrote: “The biggest problem was really to remember to document. Sometimes you had worked a whole lesson, when you remembered that you had not documented anything at all.” Another participant (#04) wrote: “Often, I documented when I paused in my work, because then I remembered to document. But I documented when someone reminded me [...] Or at the end of the day.” Hence, some participants were using both category 1 and 2 in their documentation.

3) Lecture Notes:

From the blog content, it was evident that TT was often used for note-taking during the teacher’s demonstrations. Thus, TT substituted regular note-taking methods, which was described by this participant: “My documentation included everything from demonstrations to own viewpoints and work steps [...] To me, it is important to document what has been done, so that you later on can go back and link theory to practice (#06).” Not surprisingly, it

seemed to be the link to later retrieval that was a driving force for documenting lecture notes, which is pinpointed by this participant (#07): *"The situations I chose to document, were either when I was unsure, or when I learned something new and important. The documentation will be useful to me as a sloyd teacher. Then, I can go back and remember specific details, how to use a machine or a tool."*

4) Notes of Peer Activities & Communication with Peers:

Sloyd education is a social context where students are influenced by each other in the work process [1]. This was evident in how participants in their blogs wrote about other participants' work (Notes of Peer Activities), and how they, for instance, helped each other (Communication with Peers). In the questionnaire replies there were no comments on making notes about other participants' activities or communicating through the blogs. However, some described how the social dimension influenced them emotionally, but that direct communication is still preferable: *"I thought it was rather fun to be able to see other's work. But if you have comments, or wonder about something, it is better not to use the phone (#03)." One beneficial aspect mentioned was the open access to the work of peers: "You always have access to the works of others, which makes it handy, in case you like to see something from someone else's work, or, like in the case where I had documented a mathematical formula, and a fellow student needed to obtain the same information, and it was available online (#04)."*

5) Emotional Comments:

In the blogs, participants used emotional comments to reinforce their emotions related to their work process. Examples of this category are notes of happiness about successful operations, or anxiety about uncertainty of the outcome of operations. The participants did not reflect on using emotional comments in their blogs. However, in their questionnaire replies, there were other comments related to affect: *"I enjoy seeing my own sloyd process (#04)," or: "Obviously, everyone likes to see progress, and, therefore, I took pictures to ultimately be able to create before-and-after images (#09)." Emotional comments in the questionnaire replies was also related to the social dimension, as presented in the category above.*

6) Response to the Talking Tools App:

Participants made technology-related reflections both in their microblogging during the course, as well as in the questionnaire replies. However, technical feedback in the questionnaires was on a more general level than in the blogs, for instance: *"Sometimes, the text disappeared when I wrote, sometimes pictures disappeared and the camera was not functioning properly, etc. (#09)." One reason for the general comments, might be that the blogs were written in the moment (in contrast to the post-questionnaires), when the technical interface was much more present.*

V. DISCUSSION

This study targets how participants (N=11) used the Talking Tools (TT) application for documenting their sloyd processes. In this case, the context was sloyd education for teacher students on a Master's level, as the process-based work methods in sloyd is suitable for this type

of documentation tool. The main objective of this research is to learn about challenges and opportunities, in order to be able to create teacher guidelines for how to maximize the added value of TT in various contexts. The attempt is to build TPACK knowledge [12].

The results from the first analysis of the blog content, using an interpretative approach, were validated by the participants' reflections given in the replies to the open-ended questions of the post-questionnaire. For instance, *Concurrent Process Notes* and *Retrospective Summary Notes* were both mentioned as either continual documentation of various work phases, or documentation at the end of class. However, most participants discussed documenting the concurrent process as the main strategy, and only doing retrospective summary notes when they had forgotten during the work process. This indicates the importance of discussing documentation strategies and to give reminders. Hence, the subjective data from the post-questionnaire uncovered a covert reason for the longer retrospective summary notes, which was impossible to gain from the blog content alone.

Some of the blog entries participants made were long, up to 600 characters. Entries of this nature suggest that participants felt the information useful to remember in their future profession as sloyd teachers. This is validated by questionnaire replies, in which several suggest that they documented for later retrieval of the information. One interpretation of the blog analysis category *Lecture Notes*, was likewise that the participants took notes, in order to be able to remember the most important instructions by the teacher in their own future work as sloyd teachers. This was confirmed by their reflections on both why and what they documented. They mentioned a long list of technical know-how, which they had documented, in order to be able to remember and return to the notes later on.

The objectives of the documentation need to be clear, in order for students to understand and set goals for their documentation, as well as to induce positive attitudes. Intrinsic motivation needs to be aimed for and facilitated. While learners might have their own preferences when they want to document their work process, it might be beneficial to discuss how it is possible to use the tool for reflection, for instance, by having a creative break for reflecting and documenting various phases; simply, to step back and get a new perspective on both the process and the product being made. It might also be beneficial to discuss how one can identify key phases to document in order to create a coherent story of their sloyd process.

The social dimension, including peer learning, collaboration, communication, and interaction are important affordances of TT. The results open up for further questions in relation to the learning typology of sloyd [15][16] (Figure 2), as the matrix of possible learning in sloyd does not include a social dimension. Interactions with peers were evident in two of the categories from the blog analysis: *Notes of Peer Activities*, and *Communication with Peers*. These aspects were not mentioned in the questionnaire replies. On the contrary, there were concerns about communication and interaction not going to be used as much. Such a statement implies that a new culture of communication needs to be introduced. Although, the social aspect was discussed in terms of the possibilities the open access feature of TT provides. The access to everyone's work both in school and out of school was seen as beneficial.

Peer support, cooperation and collaboration increases learning. Prior research in sloyd education point to the fact that sloyd activities are collaborative and students take part in each other's processes [10]. The present study corroborates these earlier findings of how activities develop in interaction with peers, the situation and the smartphone. The social dimension elicited positive emotions among participants. Albeit this being a small pilot study of testing TT at an early phase of development, it can be concluded that both blog content and the questionnaire replies suggest that implementing TT might increase both documentation and reflection. We are also confident that it will expand the zone of proximal development [22], through peer learning and the wider extent of the social dimension. Furthermore, the application in itself was seen as a nudge for increased documentation. Hence, TT also facilitated motivation to document the sloyd process.

The categories of what, when, and why of the participants' documentation found in this study, can be related to how Lindström distinguishes between *learning about*, *in*, *with*, and *through sloyd* [15][16]. However, the content of their documentation mostly related to sloyd specific aspects in accordance with Lindström's learning typology (see Figure 2). For instance, they saw the documentation as an aid to solve problems, relate theory to practice, reflect on their work, note down key information, and to add their own viewpoints. Furthermore, results show that all possible areas of learning, according to Huovila and Rautio [18], is not fully present in the content of the blogs, neither in the reflections of the teacher students taking part in the study. This highlights the importance of creating clear instructions for how TT can be used for a broad range of reflections in sloyd education. For teacher students, these reflections, implemented as documentation options afforded by TT, should be able to span both the teacher and the student perspective of possible areas of learning.

One purpose of this study was to validate an earlier analysis of participants' blog content using questionnaire replies. These were replies to open-ended questions about their subjective experiences of using TT. Results show that participants' post-questionnaire replies validated the categories found from the researchers' interpretations of blog content. A mixed method approach provided a deeper insight into the potential added value of TT in sloyd. In future studies it will be further investigated how TT affords documentation of both product and process in sloyd education, and especially how social interactions relate to both of these parallel dimensions.

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PAPER

PROCESS DOCUMENTATION IN SLOYD: PILOT STUDY OF THE 'TALKING TOOLS' APPLICATION

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