Pupils' Activities in a Multimaterial Learning Environment in Craft subject

A Pilot Study using an Experience Sampling Method based on a Mobile Application in Classroom Settings

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This study investigates holistic craft processes in craft education with an instrument for data-collection and self-assessment. Teaching in a study context is based on co-teaching and a design process, highlighted by the Finnish Basic Education Core Curriculum 2014. The school architecture and web-based learning environment is combined. Division for textiles and technical work is no longer supported in this multimaterial learning environment. The aim of the study is to 1) make pupils' holistic craft processes visible in everyday classroom practices with information collected by a mobile-application and 2) point out the curriculum topics that are covered during everyday classroom practices as defined by the teachers. The data is collected using an Experience Sampling Method with a gamified learning analytics instrument. Teachers' classroom activities were used as the backbone for the thematic mapping of the craft curriculum. Preliminary measurements were carried out in a Finnish primary school in grades 5–6 (age 10–12, n = 125) during a four-week period in October-November 2016. The list of classroom activities was updated after the four weeks' experiment and was tested in March-May 2017 with all the pupils of the pilot school (N = 353). The key findings were that a) for pupils the self-assessment was easy as a technical process but there were several factors in the everyday classroom settings that made the process challenging and b) it was relatively difficult for teachers to describe the classroom activities in terms of the new curriculum; however, after four weeks they could not only described the activities in more details but had also developed new activities that supported the ideas of the new curriculum better.

Keywords: multi-material craft, learning environment, holistic craft process, experience sampling method

Introduction

> The significance of crafts lies in the persistent and innovative working process and the positive experience that strengthens self-esteem and brings joy. (FNBE, 2014, 290)

This article reports research based on a pilot study conducted in a Finnish public-school classroom in basic education. Much effort was placed in the research on studying what pupils will study if they can choose between textile work and technical work content in craft subjects. The answer was that pupils chose traditionally: girls took textile work and boys took technical work, unless there were some other options (Lepistö & Lindfors, 2015; Lindfors, 2012). A pilot study with BookAI-digital self-assessment application, which is based on an Experience Sampling Method (ESM) in classroom settings, revealed the pupil's choices from another perspective.

The new National Core Curriculum challenges teachers to think about the arrangements of teaching. Nowadays, there is only one subject called craft and its key content is based on a holistic craft process

(FNBE, 2014). School practice has not always been based on this idea; consequently, there is still too often model-based learning. This is a known situation also in other counties with the same kind of school subject, for example, in Sweden (Jeansson, 2017) and Denmark (Kremmer Hansen & Wiingaard Thrane, 2015). Teachers are still often focused on the technical details of products rather than the pupils' holistic craft processes, which is also referred to as the entire craft (Hilmola & Kallio, 2016). More attention should be paid to the aims of the National Core Curriculum (Hilmola, 2014; Sjöberg, 2009) and the holistic craft process, which can be understood as a creative and reflective problem solving and design process that includes planning, making, and self-reflection conducted by the same individual/individuals, either on his/her own or in a group. (Koberg, 1981; Kojonkoski-Rännäli, 1995; Lindfors & Hilmola, 2015; Rönkkö & Aerila, 2015; Starko, 2010). In turning ideas into a viable craft product, the maker must obtain information about technologies, materials, and tools by asking, experimenting, and examining (Lepistö & Lindfors, 2015). According to the Finnish National Board of Education (FNBE) assessed learning outcomes in crafts in the final 9th grade in basic education in 2010, a substantial number of the pupils failed to show a command of the key objective areas in craft. Learning outcomes were weakest in product-making skills and product design skills. (Hilmola, 2011, 14–16).

This study is a part of a larger research and development project, called Käsitäksää. One aim of that project is to develop and study a new kind of multimaterial learning environment. The first findings were that proficiently performed co-teaching opens new didactic opportunities to develop multimateriality and the pupils' holistic processes in craft education (Jaatinen & Lindfors, 2016). A multimaterial learning environment in a craft subject consists of a basic workplace for a student and special workshops where the use of various materials and technologies is possible in a safe way. Students move between the basic workplace and the workshops according to both the teacher's guidance and independently; this is done in the way that is required by the phases of the holistic craft process. Multimaterial learning environments offer students opportunities to design, manufacture, and fabricate an innovative three-dimensional solution to a meaningful problem or a challenge at hand, and to assess the holistic process and the solution. (FNBE, 2014; Lepistö & Lindfors, 2015; Lindfors, 2010; Lindfors, Marjanen, & Jaatinen, 2016).

In this study, the scope was in creating knowledge that would help to understand the holistic craft process from the pupils' point of view. Pupil's likes and dislikes were sampled by developing an instrument, the BookAI-application, for data collection on the pupils' self-assessment in their craft processes. In recent studies, handheld devices have been used as a potential means of engaging pupils in learning (Lai & Hwang, 2015; Schneider et al., 2016). The use of mobile phones as a process documentation tool has been studied in Nordic craft education. Mobile based educational tools seem to be suitable for process-based work flow documentation in craft (Wiklund-Engblom, Hiltunen, Hartvik, Porko-Hudd, & Johansson, 2014). Process documentation reveals what is happening in different ways of learning and learning can occur about, between, in, with, and through pupil's holistic craft process (Lindström, 2012). All possible areas of learning are not fully present in mobile documentation and the importance of creating clear instructions is essential for the use of a mobile application (Wiklund-Engblom, Hartvik, Hiltunen, Johansson, & Porko-Hudd, 2015).

Based on previous studies in this development project, the new learning environment is rather a state of mind than an architectural plan. The aim in developing a new kind of learning environment for craft teaching and learning is to support and tutor a holistic craft process that begins with a need or problem of one's own. The focus is on abandoning teaching and giving more support to learning. The BookAI-application was chosen to help individual learning processes and tasks. The pilot project was one means of developing a digital learning environment together with an architectural one for deeper self-reflection and -assessment in craft teaching and learning. The data from the piloting of the BookAI-application is reported in this article. Each normal class (n = 18-23) was taught with two co-teachers. Before the fall of 2014, classes were dived into two periods of textile work and technical work. It is hoped that the results will help teachers realize the potential reasons and factors behind any motivational decrease in the pupils, and also their likes and dislikes, as well as help the pupils to understand how they consider their own craft process so as to perform better in the future. This kind of a digital tool might be one possibility to create a relevant self-assessing tool for pupils. The results help could also help to improve gamification design for craft.

The Experience Sampling Method (ESM) was used to collect real world data usually via questions or questionnaires completed with mobile devices. The data represents subjective snapshots of experiences for a given period. The data improved and became more detailed during the study, however, there is still always a subjective experience behind all the collected data. (Hektner, Schmidt, & Csikszentmihalyi, cop. 2007; Schneider et al., 2016). ESM has been widely used in Ketamo's earlier studies related to gaming and gamification. In these studies, the ESM has been embedded in the research instrument and so the ESM was designed to be a part of the user experience. (Ketamo & Devlin, 2014; Ketamo, 2014). Therefore, the aim of the study using this developed instrument was to 1) make pupils holistic craft process visible in everyday classroom practices with information collected by a mobile-application and 2) highlight the curriculum topics that were covered during everyday classroom practices as defined by the teachers.

Theoretical background and literature

Pupils' experiences and self-assessment

In craft, a pupil develops his/her skills in the craft process by hands-on doing. To be engaged in the process a pupil must be motivated. A person who feels inspired to act in a certain way and is energized or activated towards achieving a specific end is considered motivated; motivation is a multifaceted, dynamic phenomenon either intrinsic or extrinsic (Ryan & Deci, 2000) or even as amotivation. Pupils can be inherently interested in and enjoy the process and the product they are making or their work is based on outcome and reward i.e. to pass the task, thus they might not be motivated at all. Amotivation, occurs when someone does not perceive contingencies between actions and outcome (Autio, Hietanoro, & Ruismäki, 2011).

When developing a multimaterial learning environment for craft in the pilot school, there were ten major factor pointed out in the teachers' inclusive workshop held by the concept designer. These dealt with support for the pupils' self-regulation, which requires good self-assessment skills. The ten major points defined by the teachers for a multimaterial craft classroom were (Tukiainen, 2015): 1. Order and storage: a clear place for things. 2. The principle of self-direction: guidance of signposts. 3. Versatility: adaptability, mobility, and availability of classroom furniture for different functions. 4. Ambience: colors, lighting, materials, surfaces, different senses. 5. Stimulation and design examples. 6. Presentation of the work in a way that creates more value and possibilities of 3d-virtuality. 7. Space for beginning and ending rituals, as well as a place to do design. 8. Space for development and experiment. 9. Special corner for producing ideas. 10. Clear and ageless names for places that support flow at different stages of the holistic craft process. For these reasons, comparative studies were not executed. Development of new kinds of alternative multimaterial learning environments need to focus on practices and resources to promote a holistic approach (Jaatinen, 2015; Jaatinen, 2017; Lindfors et al., 2016).

According to the curriculum "The pupil's different interests and shared activities are emphasized in the teaching and learning of crafts." (FNBE, 2014, 290). Based on learning outcome evaluation in craft (Hilmola, 2011), we know that two thirds of the pupils have a positive and one third a negative attitude to craft at the beginning of the learning process. To be able to engage pupils in learning tasks a teacher should be aware of the four premises of intrinsic motivation (Henderlong & Lepper, 2002). A learning task should arouse the interest and curiosity of a pupil. The context of the task has a significant role and must have some connection to the pupils' lives and living environment. The task should also provide a challenge for a pupil, and it should respond to and develop a pupil's competence to manage the holistic craft process (Hilmola & Lindfors, 2017).

Recent research shows that the artefact to be made during the holistic craft process and the student's freedom of choice has the most significant effect on motivation. It also seems that at first it is the product, but later it transpires that the internal feedback is a key element to motivation and it seems to be critical to current learning experiences; in addition, the pupils' beliefs in their future success in tasks and in their expectation of having positive school experiences is important (Autio et al., 2011). In evaluating pupils learning in crafts three different groups of pupils were found: positive achievers, positive underachievers and negative underachievers. Negative underachievers have a negative attitude and they fail in their tasks. Despite positive underachievers failure in their tasks, they still have a positive attitude to learning. (Hilmola & Lindfors, 2017). It is evident that from pupils' motivational point of view there is need to understand their actions, likes and dislikes in more detailed. School architecture and digital learning is combined in this study to promote a holistic approach to the learning environment (Manninen et al., 2007) and holistic craft process.

Implementing a Digital Learning Environment in Pilot School

The holistic craft process and its stages were observed and focused on in an empirical classroom with QR-codes to stimulate pupil's affordances (Gibson, 1979). Affordances, i.e. the possibilities of an action in the learning environment, were mapped in an architectural plan shown in Figure 1a. This was done in accordance with the main uses of space and key content areas related to the objectives of the craft in grades 3-6: C1 Producing ideas, C2 Design, C3 Experimentation, C4 Production, C5 Application, and C6 Documentation and assessment. The area of the craft classroom in the pilot elementary school was 235 m².

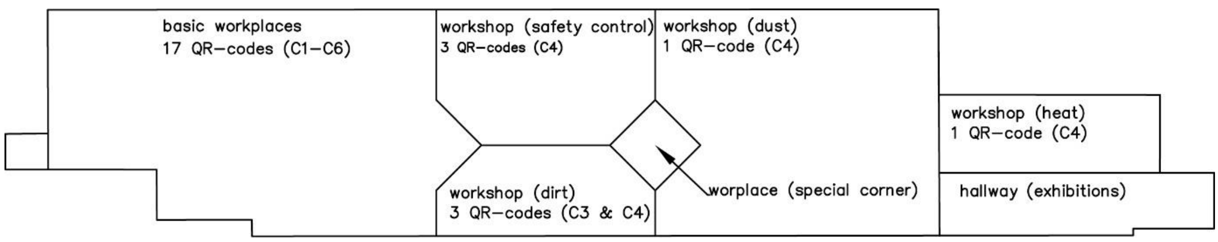

Figure 1a: QR-evaluation spots in the craft classroom plan in the first test phase of the study.

Pupils could scan, with their mobile phones, various performed actions and can thumb up or down their experiences in craft education. The pupils' interest was developed through focusing their attention, achieving positive feelings and persistence over time so that later individual interests may develop (Hidi & Renninger, 2006). This interest is measured with a new digital tool based on theories of flow (Csikszentmihalyi, cop. 1990) and zone of a proximal development (Vygotskij & Cole, 1978). Pupils typically experience deep enjoyment during the flow and attain better performance when learning is supported by collaboration with peers, for example, in the same QR-evaluation point.

Different aspects of the learning environment (Manninen et al., 2007, 15) were modified in the pilot school (Figure 1b): First, the space for learning was more like a lounge instead of a factory or traditional workshop. Second, the pupil's workplace and different work stations were supported according to different phases of the flow, not only on one side of workman's bench or a sewing machine (Tapaninen, 2002). For example, the supervisor's booth was changed to the pupils' secret corner or ideation place. Third, the working practice was more design oriented, aimed at a transversal competence and based on co-teaching. Fourth, the community was widened virtually and supported natural connections to other subjects. The fifth element pointed out by Wilson (1996, 3) on learning environment resources includes, for example, the QR-code instrument reported in this study.

Figure 1b: Modified learning environment in craft

Research design and digital self-assessment application

Research question

Based on ideas of how to support the holistic process, flow, and improve gamification design for craft, the following research question was formulated: How are pupils' activities and progression seen at a curriculum level, when using information collected by a self-assessment-application in activities defined by teachers?

Materials

In this study, the data was collected in everyday craft classroom settings and in real time for many weeks, which made new requirement necessary for the ESM instrument. To enable smooth data collection process, the idea of ESM was extended by applying QR-codes to identify the event or the action the pupils were expected to give feedback on. There was a custom made mobile application downloadable from application stores. The use of QR-codes makes the use of an application significantly faster than traditional questionnaire based ESMs: The process from opening the ESM app until the feedback (per case) is given takes only 2-5 seconds.

The first phase of research was carried out in grades 5 and 6, N = 125. All self-assessments of pupils were recorded with timestamp and coding related to curriculum concepts in October and November 2016. Altogether, 53 pupils actively used their mobile phones. Some of the pupils did not participate in the test period because they did not use mobile phones at school or they did not have permission to use it for this study. The school offered the possibility to use common devices to participate in the testing. During the first data collection, the codes were scanned 1571 times. The number of scans completed with feedback was 816. This means that almost half (755) were only scans. Teachers were advised, when this was noticed, that they should supervise the pupils to make the assessment correctly with feedback. Profiles were viewed 2100 times. In the first test period, the pupils used the software quite independently. The application was presented to the pupils and teachers by the researchers. Pupils and teachers from one 5th and one 6th grade class received personal guidance, after which the teachers took responsibility for instructing the use of BookAI.

Later, the list of classroom activities was updated after this four weeks' experiment and was tested with all the pupils of the pilot school (N = 353). From March to May 2017 altogether 131 pupils actively used their mobile phones. Codes were scanned 6197 times. Two thousand and eight scans were completed with feedback. Profiles were viewed 3901 times.

The data consisted of activity sets defined by each teacher and detailed log data about the pupil's actions in holistic craft processes in six different classes from grades 5 - 6 and group level data from grades 1-4. Materials were collected with a BookAI -application and the classroom was equipped with different action integrated QR-codes that pupils could use in describing their performance in craft learning during lessons. In the data, all the self-assessments were recorded with timestamp and coding related to the curriculum concepts. Compared to traditional statistical analysis, the size of this data required remarkable computational resources but it was not a challenge. The real-world data has multiple layers of meaningful activities. This is a real challenge in data mining, thus the mining algorithm should be able to recognize the context of data in focus. (Ketamo & Kiili, 2010).

The digital tool called BookAI-tool that makes it possible for teachers to challenge pupils with tasks of a higher level than the present skill level of a pupil is shown in the data with a time series map (Figure 2c). Individual tasks are connected to the larger conceptual framework. In Figures 2a and 2b there is an example of scanned QR-codes. Figure 2a: Safe use of the iron and ironing. Concepts: Safety, Tools, and Fabric. Figure 2b: Metal bending and cold forming. Concepts: Metals, Application, Properties of materials and Shapes. The ontology map is used as a personal profile (Figure 2c) that is colored by the users during use. The ontology map covers all concrete action related concepts in local and national curriculums. Initially, the block colors are white which means there is no assessment of the concept. The first thumb up starts with orange and later turns to yellow to show good progress. A green color shows that this curriculum concept is widely mastered by the user. A thumb down turns the color to red.

Figure 2a, 2b and 2c: Pupil interface in Finnish (Two action examples and main concepts in the local and national curriculum)

Measuring approach

Because of the origins of the measuring approach and Ketamo's previous expertise, the data collection, in general, was a game or a gamified activity. Gamification is often defined as "the use of game design elements in non-game contexts" (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011; Deterding, Björk, Nacke, Dixon, & Lawley, 2013). Gamification is applied in practice in various contexts: in designing engaging business software (Kumar, 2013), effective logistics processes (Hense et al., 2014), user experience design (Deterding et al., 2011) as well as personalized health solutions (McCallum, 2012).

By answering the questions (i.e. giving feedback to activities) the users / players gain points for their profiles. The profiles were 2-dimensional matrixes including the concepts of the curriculum. The more points a user/player had, the stronger the colors in his/her profile. In Ketamo's earlier studies the use of improving profiles significantly affected the improvement of engagement in an activity as well as better motivation towards the activity (Ketamo, Alajääski, & Kiili, 2009; Ketamo, 2014). In this context, the activity that should be motivated and engaged in is doing the ESM activities. The motivation to do craft is under experiment.

Constructing an ontology about craft

Based on Ketamo's original research done between 2005 and 2011, a Semantic Neural Network -based method to produce adaptive, real time ontologies was applied in this study. The idea radically extends the idea of Learning Objects and Learning Object Meta data. All user activities are connected to large semantic data that enables conceptual level Learning Analytics in real-time, thus, the learner can very quickly observe his/her progress. (Ketamo, 2009; Ketamo, 2011).

The entire content is based on the idea of content objects. A content object or learning object is a unit containing the smallest possible fragment of content that can be used independently without the support of any external content. The concept of the learning object is not limited to digital contexts: the learning object can be a real-world object or a real-world activity. In this study, the learning objects are single crafts activities, like designing a game, ironing a fabric, sawing with a manual saw, taking responsibility for your own work or cleaning the work space.

The learning objects are described by 1) detailed rank ordered keywords (tags, concepts) that define the themes that the content is about and 2) a difficulty estimator that describes the estimated differences in difficulty expectations between the tags. The difficulty level is not meant to be strict and general throughout the whole network. It must be accepted that there is a relatively high uncertainty about estimated difficulty. However, the semantic network at a conceptual level is very strict and this difficulty in estimation is meant to strengthen this part of the network. In the following text, the keywords concept and tag (used in the terminology of the semantic web) are used synonymously.

Each activity is defined by several keywords. The keywords construct a set of words connected to each other via the activities, i.e. the set of keywords per activity are all connected with each other because they share the same meaning or purpose behind the activity. One example is shown in Figure 3a, the keywords are connected via one or more activities.

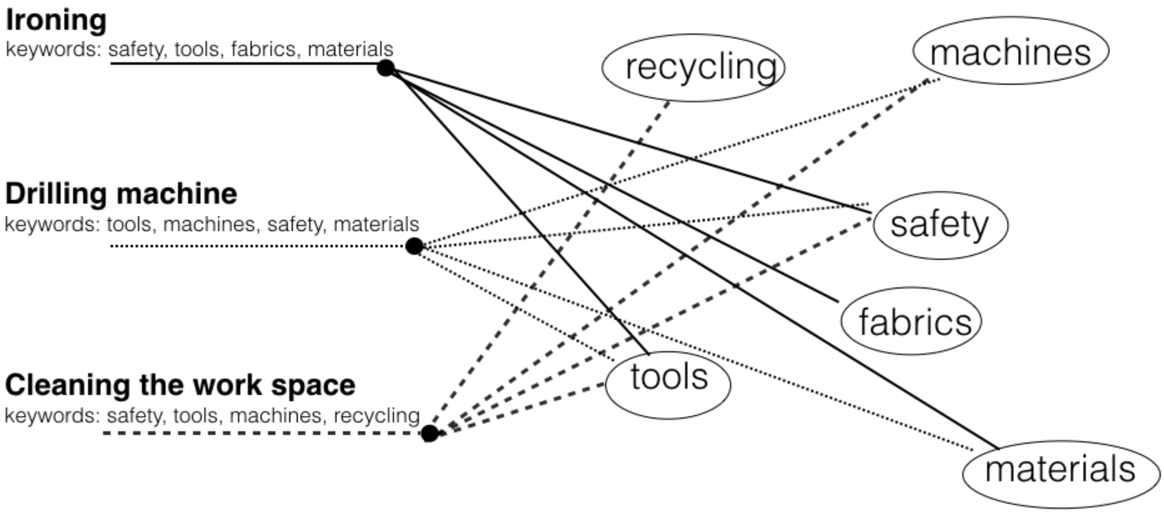

Figure 3a: Example of the relationship between classroom activities and how it is defined in the curriculum map with keywords

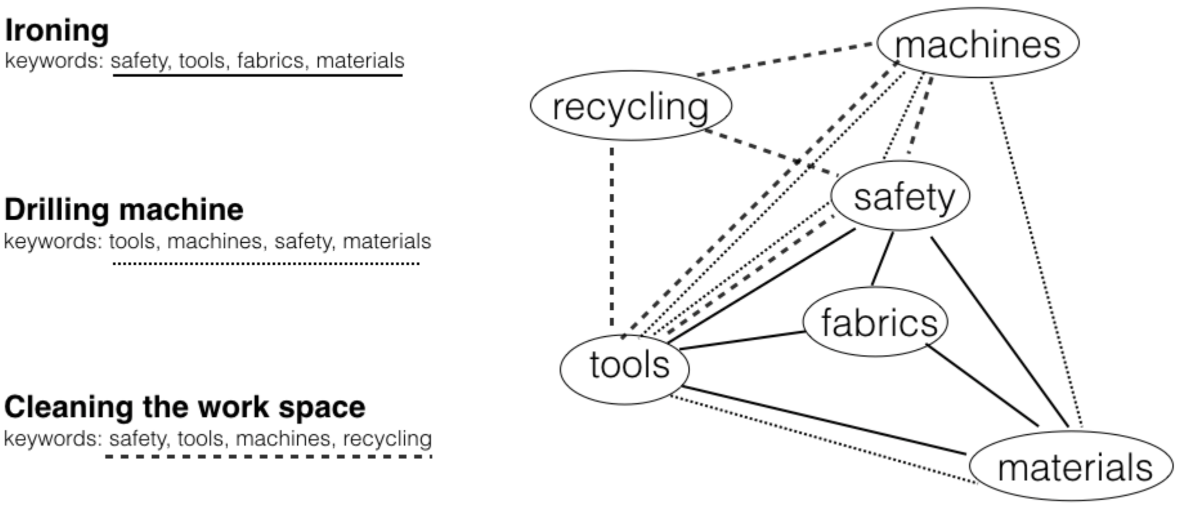

Figure 3b: Example of the relationship in the curriculum map with the keywords without the mediating classroom activities.

When the same connectors are drawn directly from one keyword to another, without the mediating activity, the strength of the different connections becomes visible. In the example shown in Figure 3b, the strongest connection is constructed between tools and safety (strength 3 connector lines). Furthermore, most of the connections have only a connector line, which may indicate the connection is superficial.

The semantic network is computationally built according to tags defined in the content objects. Each content object (Figure 3a) has several tags, which form the first layer of the network. When two tags are used to define one content object, the tags were considered connected with a strength 'one'. If the same tags are used to define another content object, the strength of the connection between the tags is again increased by one, i.e. the strength is two after this. In terms of graph theory (in mathematics) tags are seen as vertices and connections as weighted edges. The more relationships between the tags that are observed (Figure 3b), the more related the tags are in the semantic network (Figure 4a). These networks contain 1) a detailed knowledge representation of the content at a conceptual level. According to this conceptual knowledge representation, the relationship between content objects can be mined easily. In other words, the semantic network offers the possibility of easily managing relationships between the content objects. This kind of structure offers numerous possible paths through the material.

Development of action tasks given by teachers

QR-codes for self-assessment were developed in the teacher's workshop. In this article, first the four-week period is shown from the pupil's perspective. More detailed measuring points for holistic craft education were added after our experiences with the new instrument. A teacher application is under construction. With a visual summary, a teacher can realize better the potential reasons and factors behind any motivational decrease and help pupils perform better in their individual processes, as well as develop co-teaching. Visualized relationships within the subset of the Finnish crafts curriculum were built according to the keywords of all the activities and defined for first test phase; these are shown in Figures 2c and 4a. Some concepts are in the outer layers and not strongly connected to other actions.

The relationship between content objects within the subset of Finnish crafts curriculum are equalized. The relationships are based on the method described in Figures 3a and 3b. The visualization shows only the strongest dependencies between content objects. The closer the objects are in the visualization (Figure 4a), the closer they are as clusters to each other. According to the National Core Curriculum the key content areas in grades 3-6 are: producing ideas, design, experimentation, production, application and documentation and assessment (FNBE, 2014, 291–292). Teachers from 5th and 6th grades were asked to list the actions the pupils would be performing in next month. Twenty-six actions were listed. Most of the first defined actions related to the production phase for the key contents of crafts. One was directly linked to producing ideas, five to design, but experimentation was not understood as an independent action in the craft process. Three actions were strictly linked to documentation and assessment.

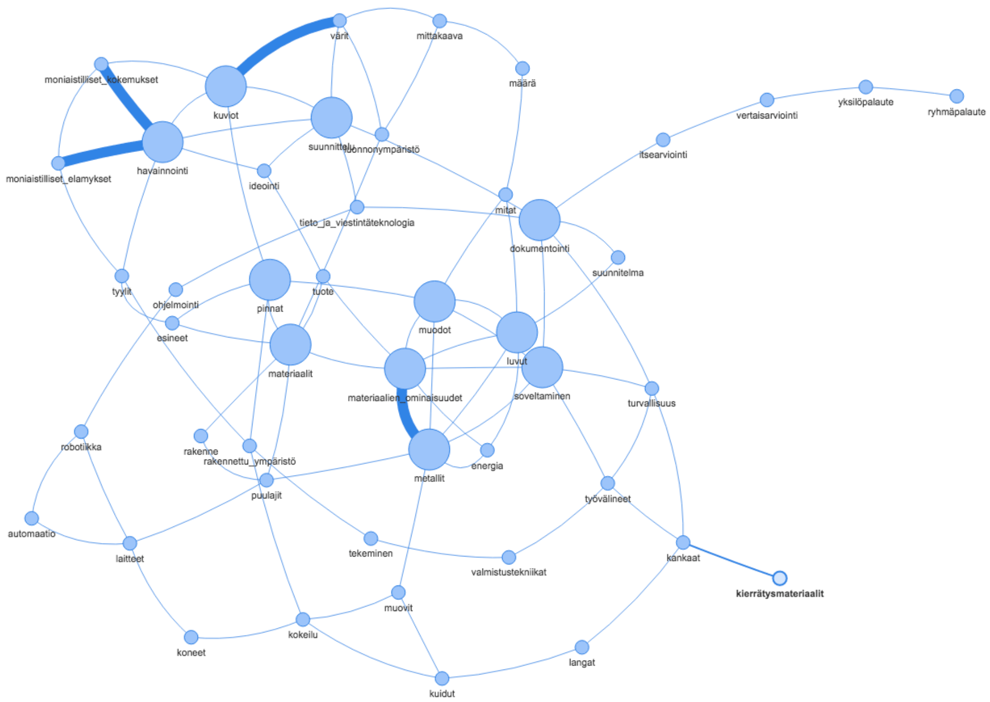

Figure 4a: The semantic network in Finnish, built according to the keywords of all the activities as defined for first test phase.

Results

Overview of results

The answer to the research question is first presented by introducing three individual pupil's actions and progress shown in the semantic maps, and two different kinds of group examples of use from first test phase that reveal the curriculum level. Later the semantic network is shown, which was built according to the keywords of the self-assessment activities as defined by the teachers and used in the application in second test phase. Then two different kind of use are introduced with group level examples with an updated action list. Two installations out of the 131 could not be performed: one because of an unsupported operating system and one because of a lack of memory in the device. The number of performed scans without feedback in the beginning represented 53% of all scans, and after more detailed and frequent instructions the percentage increased to 67% of all scans.

Progression of pupils' individual semantic maps

The semantic maps illustrate in Figures 5a-5c the progress of the pupils (left 1st week, middle 2nd week, right 4th week). Progression of the semantic maps with relatively typical individual progress are shown in Figures 5a and 5b. The first week was spent learning to use the system and the progress in following weeks is then visible (Figure 5a). Figure 5b compared to Figure 5a shows that this pupil has done more work in weeks 3 and 4 while the pupil in Figure 5a has done maybe most of his/her work in week 2. In Figure 5c the progression of the semantic map is shown for a person who was perhaps just scanning the codes in the first week. The person has scanned and evaluated significantly more tags than his/her classmates in general. Furthermore, there is no clear progression in the following weeks, which may indicate that the person was not interested in using the instrument in the following weeks; pupils have different play styles. A pupil's absence or cancelled lessons were not reported in the application.

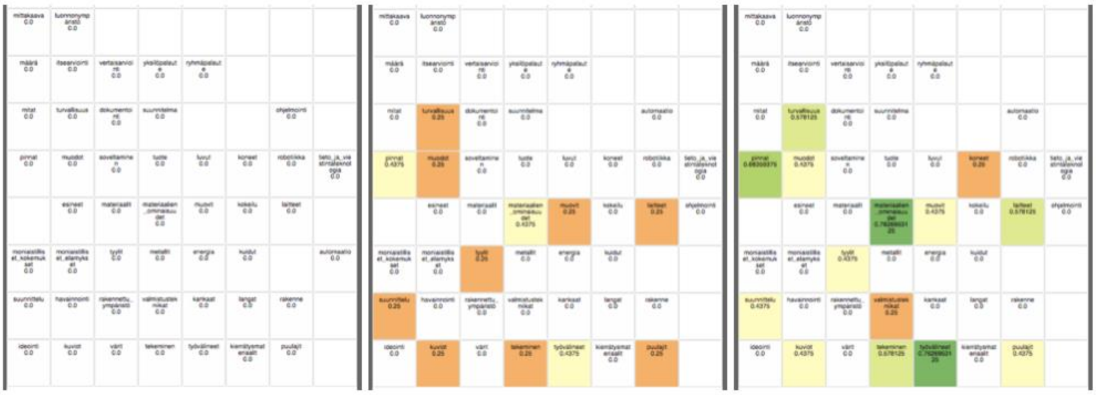

Figure 5a: After learning to use the system the progress in the following weeks was visible.

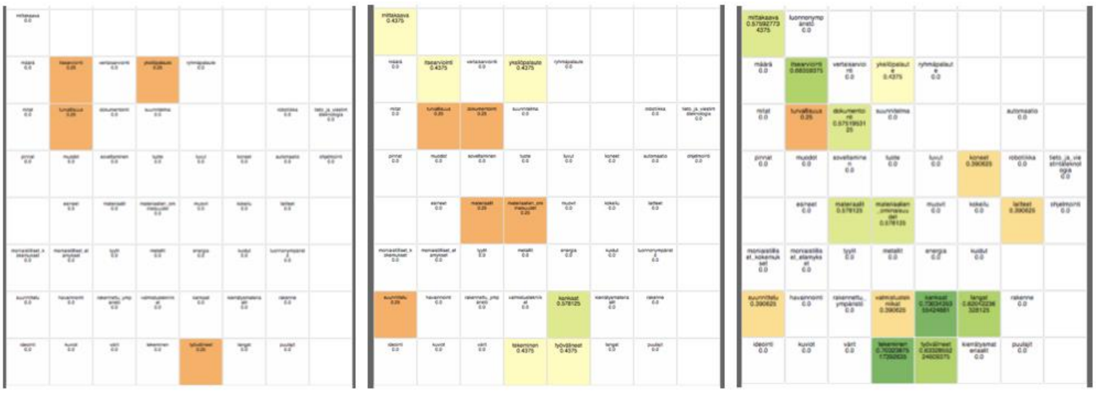

Figure 5b: Advanced user and progress in each week

Figure 5c: User who perhaps just scan the codes and create significantly more tags than in general.

Progress as illustrated in the semantic maps at group-level

Figure 6a shows the progress of a group which had a good start and good progression in the following weeks. Figure 6b shows a group that had a difficult start (no scanned QR-codes) and a difficult week 2 (red/negative feedback in numbers and patterning), but which finally ended with a positive map with a relatively large number of activities. The current assignments in the classroom were to modernize a traditional wooden milking stool and re-use an old dress shirt. The topics were design, wooden structures, ergonomics, finishing, neatness, adaptation of clothes, dyeing, using the sewing and overlock (serger) machine safely.

Figure 6a: Group with good start and good progress in the following weeks.

Figure 6b: Group with a difficult start and negative feedback in week two but finally with good progress.

The green color in the map deals with such concepts as fabrics, design, tools, safety, threads, individual feedback, and self-assessment. Assessment is also a skill that needs to be taught; however, it is not so fascinating for the pupils to do self-assessment unless changes are made in classroom practices by the teacher. That can also be seen in semantic maps. In the first test phase, the most active class had all the pupils using BookAI, but in contrast in one class there were only 3 pupils from 20 doing self-assessments with the application. This short test period was not long enough to cover all the curriculum concepts; consequently, many of the concepts on the semantic maps remain white.

Progression of semantic network

The activities defined by the teachers show that changes in conceptual levels are challenging. The different actions of the key contents have now been modified so they are more systematically focused as regards scanning on the architectural plan (Figure 7). In the National Core Curriculum craft is defined as a design process, but in craft classrooms it is mostly defined as a producing process. The new concepts that were listed and coded on the application after the test period (Figure 8) show that the curriculum concepts have been considered more precisely. The semantic network is more dynamic; 54 new action tasks were added and seven new curriculum concepts.

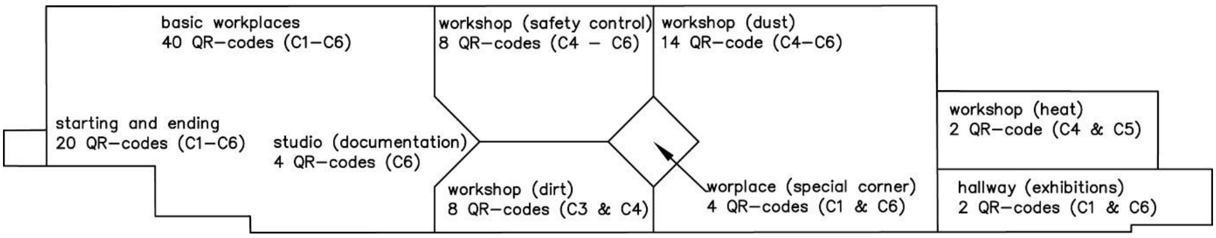

Figure 7: Second test phase - QR-evaluation spots on the craft classroom plan.

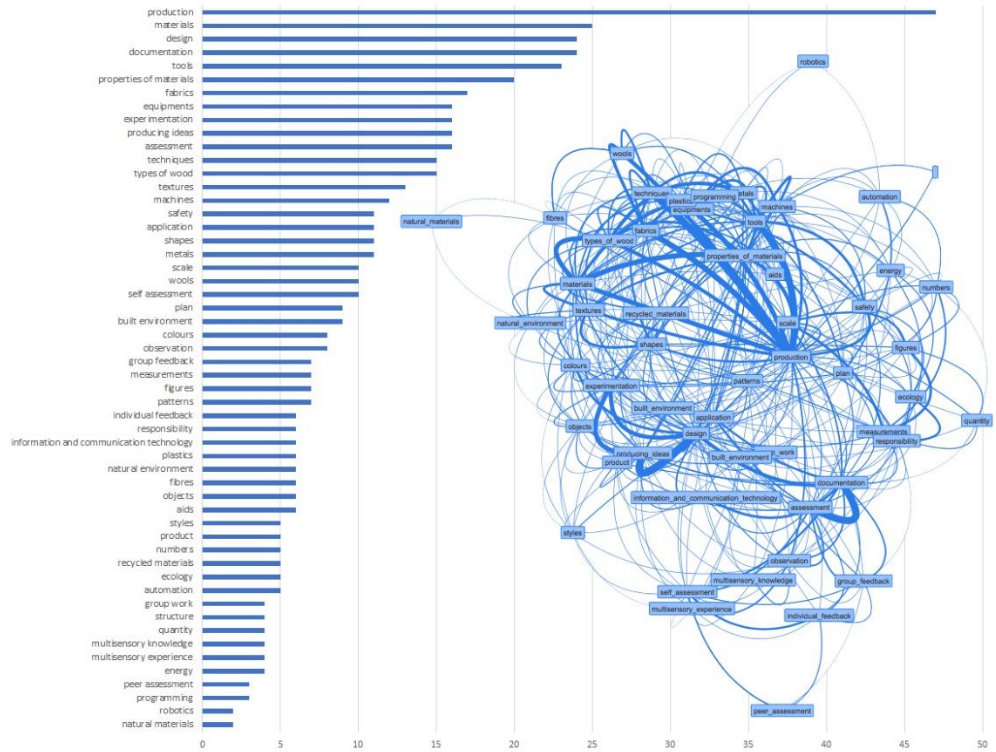

Figure 8: On the left is the frequency of the 54 keywords in the system and on the right the semantic network, built according to the keywords of the activities defined for the second test phase.

In the second phase, most of the defined actions were still related to the production phase of the craft key contents. That was obviously because multiple materials were used in the craft. Producing ideas have now become connected to 16 actions. Design was linked to one fourth of the actions, but not closely related to the production phase. Experimentation was also understood as an independent action in the craft process. Documentation and assessment actions were diverse, but somehow the continuum in the holistic craft process was not obvious as regards the production phase. Production became directly linked to 47 of 138 action codes. Natural materials, peer assessment, programming and robotics can be seen as quite rarely connected to action tasks.

Progression of semantic maps in group-level after updated keywords

One 6th grade class took the application as an everyday routine. In Figure 9a the progress at the group level is shown. There were only a few curriculum concepts that were not covered by the teaching/possible actions. Ecology and responsibility turns red in this illustration where one minus equals eight plus. The indicator color system was changed to meet the idea of pain points better. Ecology and responsibility have been colored red. In the graphics, shown in Figures 2c, 5a-c & 6a-b the color turned greener, according to the most recent likes. The total number now shows whether there are some concepts that can teach and motivate all the pupils better.

Figure 9a & 9b: One group from the 6th grade with many participants during both test periods (n = 21) and new users in the second test phase from the 4th grade (n = 60).

The 4th graders started to collect their data in March and it has been visualised in the grade level in Figure 9b. Teachers were familiar with app. One curriculum topic is not covered in the actions: natural materials. This concept occurs only twice in the system (Figure 7). Wools, fibres, and safety were the least liked concepts. There were also two grades without participation with white maps. First graders started to use the application in one week in the craft classroom with two shared devices. The maps are similar to those groups shown in figures 6a and 6b after four weeks of experience.

Discussion and Conclusions

The research design of the study followed the ideas of the Data Mining paradigm (Ketamo & Kiili, 2010; Ketamo, 2014): When the data size is large enough and there are sufficiently detailed data points, the data analysis can reveal valuable knowledge. In this sense, the collected data sets limits on how it could be analyzed. Firstly, the self-assessment was a technically easy process for the students but there were several factors in everyday classroom activities that made the process challenging. For example, some pupils were perhaps too critical and did not assess topics they felt they could not master perfectly. At the same time, some other pupils evaluated all the codes they could find no matter whether they had really done such activities or not. This controversy is related to self-criticism and the lack of any self-criticism is a real challenge for all the current and future analysis made with this kind of implementation.

To obtain a deeper understanding of what happens in a pupil's self-evaluation, the application needs more detailed features, such as interactive peer-assessment criteria (Lai & Hwang, 2015) or multimodal documentation, communication, and instruction (Wiklund-Engblom et al., 2015). On the other hand, the Experience Sampling Method (ESM) highlights subjective experience and it is a general feature of the method, not a failure (Hektner et al., cop. 2007). It seems, there are features in the measured user activities that could reveal unexpected use of the instrument. Subsequently, in the next study, a filter for recognizing impulsive behavior or lack-of-self-criticism will be implemented. The use of Book-AI was easy and there were no major challenges in using the system after it was installed successfully. It seems that scanning was more popular than evaluation. Scanning is perhaps more like playing, not a thumbing and adding color to your pupil interface. We can no longer assume that this happens because of a lack in the instructions because the percentage of all scans increased from 53% in first test phase to 67% in second test phase. By scanning it is possible to obtain key concepts related to the topic. This is good to notice when developing the screen that is revealed after scanning without thumbing. It still takes time for all pupils to implement this kind of assessment as an everyday practice.

When focusing on the results of the pupil's self-assessment, there were more positive cases than negative ones. Every craft process needs trial and error, so every minus is not negative. In fact, there was only one negative or unexpected archetype for the individual users: those with no self-criticism. In the context of a long-term study, all the too self-critical pupils managed to do well and their informative self-assessments and profile, as a time series, was as useful for the teacher as the profiles self-assessed by 'typical' pupils. With all those individual progress profiles, the teacher can easily see what the pupil has done during the term or school year and so the teacher can be sure that he/she has covered all the topics the curriculum is meant to cover. Furthermore, the teacher can see the individual pain points and support intrinsic motivation (Henderlong & Lepper, 2002). In this study, the sample was too small to name typical pain points, but e.g. 'fabrics and yarns' or 'measuring' were pain points for some individuals. At the group/class level the visualized curriculum maps can help the teacher to plan activities. For example, if there is a certain area of the curriculum that is completely unevaluated, the teacher can get ideas about what he/she should focus on in the next work/activity. In cases where the curriculum topics are assessed as negative, the teacher can redesign his/her teaching to better meet the expectations of the pupils. This is especially important with negative underachievers whose negative attitudes prevent them from achieving good learning outcomes (Lindfors & Hilmola, 2016). In the study, there was one class that, according to the measured data, was feeling negative about most of the work but after four weeks their class profile became positive. For any teacher, it is crucial to notice when some changes in the teaching method are necessary.

The modelling of the curriculum map was based on the classroom activities given and defined by the teachers. Initially, the activities were mainly technical activities, like 'sawing', 'drilling', knitting' or 'ironing'. The design, evaluation and documentation activities were mostly missing. In the updated, second phase, the teachers made better sets of activities. The activities covered most of the curriculum topics. Teachers are not always oriented towards the craft curriculum (Hilmola, 2014), but in the pilot school it became more familiar to all the teachers due to the BookAI. Furthermore, some of the teachers developed new activities which matched the new curriculum better. The definition of pupils' activities as well as mapping activities forces teachers to think about the relationship between classroom activities and the curriculum. In this sense, the process developed the teachers' ability to focus on the ideas of the Finnish Basic Education Core Curriculum (2014). It will take time to cover all the relevant concepts in the nine years of basic education (the seven first years are mandatory in Finland).

In general, teachers seem to need support when implementing the new curriculum in the classroom. The teachers master the doing-related topics perfectly, although pupils do not learn to manage product-making by themselves (Hilmola, 2011). Teachers might need help to see the whole idea of the key contents of the craft curriculum, including co-creation, designing, documentation and (group)assessment. For pupils, it is not easy to grasp the idea of a holistic process, until the idea is clarified by teachers. In this study, we implemented a conceptual model of the curriculum that was assessed with the Experience Sampling Method. It seemed to have helped some pupils and teachers to grasp the idea of a holistic craft process. There were also pupils and teachers who does not feel this application was useful in their learning and teaching. Although the use of the application is intended to be an action to document and assess learning and teaching, a small minority of teachers did not use the application.

Visualizations make the different processes of pupils visible and teachers as content providers can highlight different curriculum topics. Pupils' Activities in a Multimaterial Craft Learning Environment are still based on the options offered by teachers. Although the options of textile work and technical work are no longer available, teachers are still willing to believe that certain techniques must be studied and trained before and not during the holistic craft process (Jaatinen & Lindfors, 2016). In this study, we have pointed out that the key concepts of craft are not equal. Producing is important, but more specified ideas about how to teach other phases of holistic processes are needed. The results were promising and next phase of the research includes more detailed interviews and questionnaires about user experience (pupils, parents, and teachers), improved visualizations and testing in upper grades. Scanning is one key element to improve gamification in craft; it should give the pupil more valuable knowledge as regards the learning process. The conceptual model of the curriculum and the list of classroom activities is going to be developed in co-operation with craft teacher students, teachers, and pupils of the pilot school. The aims were to make the holistic craft processes of pupils visible with this developed instrument and to point out the curriculum topics. These results can be used when developing methods to support educational change from model-based and product oriented working methods to holistic craft process that highlight design and evaluation as well as manufacturing and product orientation.

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