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Abstract: This paper focuses on students in the youngest classes at primary school as learning designers of ICT-integrated productions. It is based on the project *Netbook 1:1* (2009-2012) funded by the municipality of Gentofte and Microsoft Denmark. The paper presents a model for designing ICT-integrated student productions which was developed during the project in relation to different subjects. Ownership, iteration and feedforward are the central concepts in this model. Two exemplary cases are presented illustrating the students' and teachers' roles as learning designers in relation to the model and based on the project data. These two cases highlight the project's central findings: in these designs for learning, ICT-integrated student productions can facilitate student learning processes and qualify their learning outcomes.

Introduction

In recent years, Web 2.0 has made everybody potential transmitters, receivers, producers, participants and collaborative partners. As a result, new opportunities for learning have emerged. This paper raises the question of whether or not ICT-integrated student production facilitates students' learning processes and/or qualifies their learning outcomes. The project Netbook 1:1 explores the combination of ICT, production and subject matter-specific practice in Years 1-3 at two Danish *Folkeskoler* (Municipal primary and lower secondary schools) where ICT is readily accessible and where each child receives a personal Netbook which can be used both at school and at home. The research project was conducted during the period 2009-2012 as an interventional and transformative project where the researchers took part in the development of ICT-integrated designs for learning and assessing their impact on learning outcomes and learning processes, especially in the subjects Danish and Mathematics. Important parameters for the research were formal and informal learning processes, knowledge sharing, learning environment, student and teacher competences, and student and teacher as learning designers. We are inspired by Dale´s three didactic levels (1989, 2000): Practice, Planning and Theory. However, we attach great importance to *reflection in action* (Schön 1983) as a result of our understanding of the term *design for learning* as a process- and agency-related concept. We connect this approach to Dale's levels as Practice, Planning and Reflection. Given the fact that both students and teachers act as learning designers in the project, it is important to examine whether students are also capable of operating on all three levels and possible significance in terms of their subject-related learning. With this in mind, a pivotal point of the project is how to develop a design for learning model for ICT-integrated student productions.

Production as design for learning practice

Many years of experience with the positive learning outcomes resulting from production and collaboration has afforded project work a formal status within the Danish education system, from primary to Master's level. Reflection and learning have been shown to be augmented by the shared responsibility for both working process and product at the very core of project work (Berthelsen, Illeris & Poulsen 1977; Borgnakke 1983; Dirckinck-Holmfeld 1990 and 2000). As a result of the comprehensive digitalisation of society (Castells 2000, Qvordrup 2001), the principles of project work have been refined within e.g. Computer Supported Collaborative Learning (CSCL) where ICT functions both as an artefact and a resource in face-to-face teaching and as the medium of communication in online courses (Dillenbourg 1999, Koschmann 1996, Littleton et al. 2005, Dirckinck-Holmfeld 2012). With the spread of Web 2.0, Wi-Fi and mobile units, increasingly in the shape of Smartphones, the concept of project work within the Danish *Folkeskole* has expanded to include the production of multimodal content. At the same time, learners bring with them digital competences exceeding those of their teachers; competences which it stands to reason should be incorporated within formal education by taking learning approaches common within informal

learning contexts into account in the design for learning (Selfton-Green 2006, Wenger 1998; Wenger, McDermott & Snyder 2002, Sørensen, Audon & Levinsen 2010).

It has been extensively documented that the multimodality of ICT – both as a sensory modality and as a system of symbols – together with the possibility of interaction, generally stimulates students' motivation and thereby also their learning. Research concerning the effects on subject-specific learning is in shorter supply. Examples of research considering learning outcomes when the focus is on production can be found in courses for young people and adults, particularly in England, where students produce video content and podcasts using Web 2.0 services and SmartPhones. The research documents that students are motivated by producing their own material. Lee, McLoughlin & Chan (2008), Miller (2006) and Cebeci & Tekdal (2006) argue that the true potential of podcast- and video-technologies lies in the knowledge-creation process, and its use as a vehicle for dissemination of learner-generated content. Atkinson (2006) stresses this even more by stating that "The emerging developmental and research direction seems…to be learning through *creating* podcasts and similar, in contrast to learning *from* podcasts" (p. 21, emphasis in original). Smith, Sheppard, Johnson, & Johnson, (2005) found a significant increase in grades among students involved in creating podcasted lessons. Lazzari (2009) produced similar findings along with the finding that consumption of podcasts appears to be pedagogically neutral. According to Lazzari, students' involvement in producing their own short lessons improves their performance, promotes cognitive elaboration, and enhances critical thinking. When it comes to children, practitioners working with Papert's constructionism, in partnership with Lego among others, have developed designs for learning by incorporating knowledge concerning children's cultures of play and informal learning approaches. Here, students acquire knowledge by constructing and producing with Lego Mindstorm (Druin & Hendler 2000, Resnick 2007) and other robots (Raffle, Parkes & Ishii 2004). Other studies of collaborative production of shared (digital) products in terms of artefacts find that the combination of (re)negotiation of meaning and (re)organization of materiality during activities such as idea generation, problem solving, experimentation and construction emerges as an important impetus in the production process. (Re)negotiation of meaning and (re)organization of materiality facilitate students' reciprocal dialogue, reflexivity and learning of the subject matter (Turkle & Papert 1992 , Miller, Tichota & White 2009, Plowman 2010), and is further facilitated by interactive affordencies related to ICT (Sørensen, Audon & Levinsen 2010).

Without dismissing the value of presenting and receiving feedback on a product, positive experiences with a greater focus on the creative process have constituted a key source of inspiration for the development cases and designs for learning at hand. In relation to the students' creative processes, focus has primarily been on the combination of the interactivity and multimodality of ICT, dialogic (re)negotiation of meaning and (re)organization of materiality when employing digital editing and production resources, and production.

The study was conducted from 2009 – 1212 at two Danish *folkeskoler,* involving preschool 1, 2 and 3 class, in all approx. 150 students and 6 teachers. We used a mix of methods. Qualiative: 8 formal interviews and 12 focusgroup interview with the teachers; 6 students focusgroup interview (15 students); informal interviews with teachers and students (50); 45 participant observations á 2-5 hours duration, following groups and/or individuals and documented as thick descriptions; 30 videorecordings of isolated situations. Quantitative methods: Collection of formative national assessments; formative test. Additionally we collected and analyzed student productions.

Two Cases – *My Shop* and *Professor of the Month*

In our previous research projects (Sørensen, Audon, Levinsen 2010), we have documented that students achieve higher level learning objectives, work independently, as well as functioning as learning designers on the first two levels: Practice and Planning when designs for learning integrate student productions and ICT. In the cases presented below, we document how students also reflect on the third level. It is clear that this reflection is practice-based for students, as opposed to the theory-based reflection in action of the teachers. In our analysis of empirical material stemming from several different courses of study, both single subject and cross-curricular, where the students worked with ICT-integrated production, we have documented how ICT-specific affordances supports students as learning designers of their own learning processes when required to

- seek out and select information
- acquire new knowledge
- train, differentiate and consolidate knowledge

- transform information into knowledge
- acquire new multimodal repertoires
- communicate knowledge to others
- produce learning resources for other students

In this paper we have selected two representative and exemplary cases demonstrating the central findings of our research. *My Shop* is a course of study in Mathematics where students learn to master addition, subtraction, multiplication and division, and, on this basis, develop and produce ICT-integrated learning resources for each other in the form of assignments. As such, they are learning designers of learning resources with their peers as target group. *Professor of the Month* is a cross-curricular project where students individually take turns to carry out research, acquire knowledge, and plan a presentation for their classmates on the basis of an interest in a particular subject. In this case, the students are learning designers in terms of both their own ICT-integrated acquisition of new knowledge and the communication of this knowledge to their classmates. When students function as learning designers, planning, organising and performing the productions, they establish ownership of their own learning processes. As well as planning and performing the processes, they make qualified choices regarding learning design categories such as objectives, content, organisation and use of technology. Correspondingly, the teacher's function shifts to that of general leader, facilitating, supporting and challenging students while maintaining a theory-based reflection in action as learning designers.

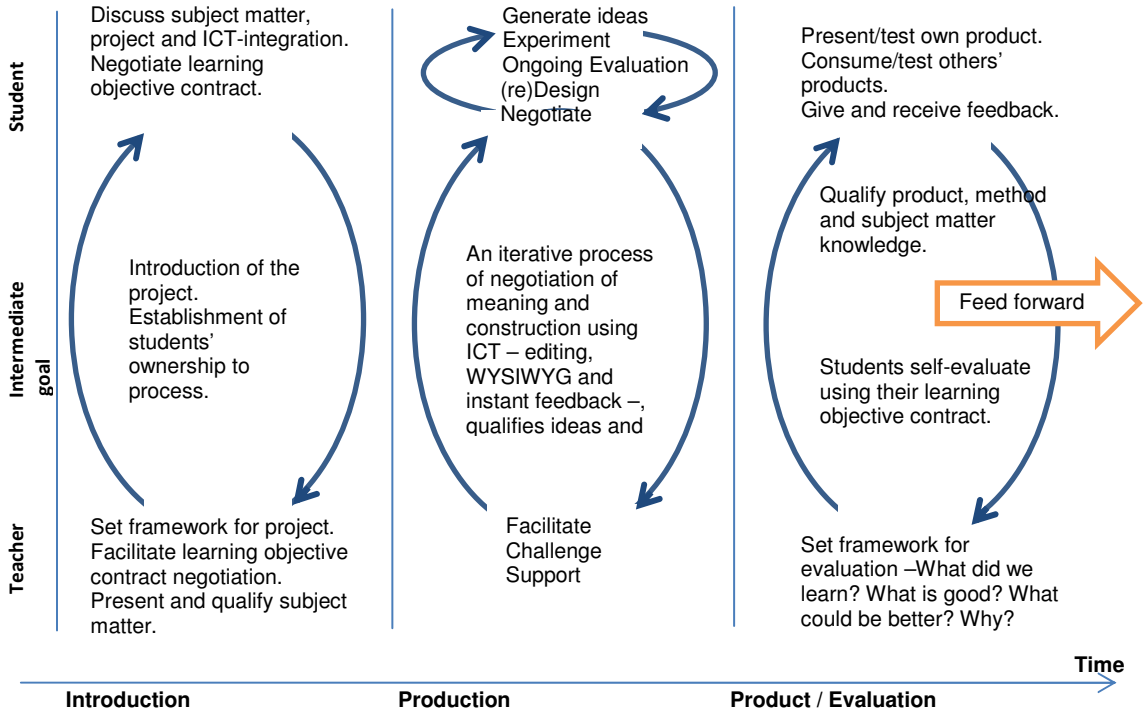

Figure 1: Design for learning model – ICT-integrated student production (WYSIWYG refers to the intuitive interaction design concept What You See Is What You Get)

All learning designs implemented within the framework of the Netbook 1:1 project share the same basic planning and performance processes illustrated in figure 1. Iteration is a common theme within all of the three main stages: Introduction, Production and Product/Evaluation, with all feedback also functioning as feedforward; i.e., all iterations include reflection on the question "where did we come from" and the directions "where are we headed". This takes place in the form of a back and forth between (re)negotiation of meaning and (re)organisation of (digital) materiality, as expressed by the arrows which also indicate the shifts between teacher and student control.

My Shop - Mathematics

With digital aids such as calculators and spreadsheets, machines can solve mathematical problems for us. Students need to understand mathematics within the context of a concrete reality (Ministry of Children and Education 2009), and be able to establish the conditions according to which the machines are to perform their calculations. The main challenge for teaching Mathematics today is how students are to acquire mathematical knowledge in the form of concepts, practice and language which can be applied in order to "figure something out". A common method found in Maths textbooks is the use of mathematical stories following a model where the student reads the story and solves related assignments. In the case *My Shop,* the students themselves construct the problem-based mathematical stories which are to incorporate the four basic forms of arithmetic alongside the mathematical concepts differential, sum and decimals. The topic is commerce and students are to use authentic prices and pictures found online and to produce their mathematical stories using presentation software of their own choosing. The rest of the class have to complete the assignments which are shared on the class-web and offer feedback as to whether they functioned as intended and whether they learnt anything, as well as offering suggestions for improvements and examples of what worked. When students construct assignments themselves, they are able to apply their existing mathematical competences in a subject-related and creative process, and to explore the periphery of their zone of proximal development (Vygotsky 1962). At the same time, they gain experience in reading subject literature and in applied mathematics, and they are forced to reflect as learning designers on the subject matter in order to create good, fun and educational assignments for their classmates. It is a requirement that the students are able to explain how to complete the assignment, both orally and in writing.

Figure 2: the students read the process description and their learning objective contract on paper and work in pairs with their assignment on the Notebook

My Shop progresses as illustrated in figure 1. Each day commences with a plenary session where the tasks for the day are discussed: How far have the students got? and What is important? The first day is about establishing ownership of the process and introduces the mathematical language and concepts. Together, the class agrees on the framework for the product and the learning objectives (Fig. 2). These agreements are written in the students' learning objective contract. Midway through the iterative production process, the students are at the helm, while the teacher checks whether "all bases have been covered". At the end, the assignments are collected on the class intranet so that everyone can try each other's assignments. The students were allowed to pick the shop's specialty themselves. This results in a wide array ranging from pets to footballers, from sweets to supermarkets and cafes.

The design for learning, with its strong focus on the iterative production process, offered the teachers ample opportunity to observe and challenge the students. An important finding was that differentiated learning was an automatic part of the process. The content and level of complexity reflected students' academic competences, while the iterative production process reflected academic progression. The design for learning with ICT-integration accommodated students' varying approaches to learning and they took the mathematical content seriously. In the iterative production process, students' cognitive breakthroughs occurred during discussion and reflection regarding

their ideas about and experiments with their designs for learning. The awareness that other students would have to complete the assignments helped maintain a focus on the mathematical subject matter, and students realised that unrealistic or irrelevant assignments would be either too difficult or uninteresting for their peers. Furthermore, we found that the fact that students had to be able to complete their own assignments and to explain their methods both orally and in writing had a considerable cognitive effect. During this process, many of the assignments were adjusted as students realised their mathematical stories were unclear or too complex in relation to their own level of competence within the subject. The process of completing the assignments designed by their classmates also demonstrated the students' mathematical competences. Communication and dialogue using the language of mathematics were a necessity in order for students to be able to express their own way of thinking and their understanding of classmates' ideas and proposed solutions. The products provided numerous examples of students exceeding the stipulated learning objectives for their year group and working at a level not expected until later in their schooling. For example, the concepts *number of units* and *a set* are indirectly introduced, as represented by pictures of two piles of sweets (sets) and the number of sweets in each pile (number of units belonging to the set). The assignment in this instance was to find the total number of sweets. Such a level of abstraction far exceeds what is generally expected of students in Year 2. Another example is how students' interest in football leads them to form arithmetical problems using large figures such as millions based on footballers' wages.

Professor of the Month – cross-curricular project

Professor of the month is an example of an individual student project where the objective is that students explore and immerse themselves in a topic of their own choosing which particularly interests them. This project is to be presented to the whole class (see below). *Professor of the month* is so popular with the students that they use their free time, both at the school's recreation scheme and at home, working on their projects. As part of this concept, teachers employ knowledge about children's cultures of play and informal learning processes. They attach considerable importance to the topics which interest children and create space for these topics within the classroom, providing links to subject-specific content as stipulated by curricular requirements. Once again, the teachers emphasise the aspects of the productive processes which promote student motivation, participation and activity. Topics such as dirt bikes, football, and singers like Amy Winehouse are not traditional scholarly topics. However, when students bring them into the school space, an academicization of these topics occurs; an academicization which the students take part in.

3a.


3b.

Figure 3: Walter is presenting his PowerPoint about dirt bikes (a), and afterwards (b) he sits in front of the final slide and answers questions and receives feedback from his classmates

Walter, a student in Year 2, has chosen to draw on his interest in dirt biking for his *Professor of the Month* presentation. At home, Walter has prepared a PowerPoint which he will show and use as the basis for his presentation. He tells the class about his passion for driving 4-wheeled dirt bikes. The PowerPoint has an attractive title slide with an overview of the content of Walter's presentation, and a video of him at home, driving around on a track in his father's field. There are facts about his bike and about safety equipment. In his oral presentation, Walter speaks quickly and excitedly.

When the students work on their professor projects, the teacher functions as "project manager" at a general level, thereby assuming an important function as a catalyst for the students' development of the necessary competences; e.g., to design their project. In relation to the three levels we introduced earlier: Practice, Planning and Reflection, as learning designers, teachers and students will operate differently on each of the three levels. The teacher's preparation consists of explaining the concept to students, so they understand what it is all about. They use a fair amount of time on this at the beginning, but gradually, as an increasing number of students have had the role of *Professor of the Month*, a common frame of reference is established which partly automates the process, creating a set format with room for variation. During the preparatory phase, Walter assembles a PowerPoint and plans his oral presentation. He chooses a format of presentation followed by a test of whether or not his classmates have listened, understood and learnt. He prepares questions which the other students are to answer on paper. He reflects on the sequence of activities, and on what content to include based on its importance. He also considers how to involve others and ensure they get something out of it, and what is the best way of collecting answers. During Walter's presentation, the teacher assumes a position in the background. The teacher has established the framework and stipulated requirements, but has done so without exerting control. During this phase, Walter realised that completing the assignments in written form is taking too long. The students write down their answers, but Walter does not collect them as he had planned. Instead, he runs through the test orally, gauging whether or not his classmates had answered each question correctly by a show of hands. In other words, he modified his design, but maintained the original intention. During the evaluation, the teacher once again establishes the framework, asking two general questions: "What was good?" and "What could you do better next time?"; however Walter chairs the discussion and answers the questions. The teachers make note of what is said and use it to qualify subsequent individual conversations with students regarding their learning objective contracts. The teacher helps maintain focus on what is relevant. Students, both those performing and their classmates, understand why it is a good idea to listen to and embrace critique. The dialogue provides both the performer and future *Professors of the Month* with ideas.

The development of these presentations can be regarded as a collective creative process, whereby students build on each other's ideas and concrete learning designs, and, in some cases, develops presentations which function as communication in a learning perspective. Within contemporary creativity research, creativity is viewed as something which can be learnt and promoted through education (Tanggård 2006). The students' way of working with these projects involves a creative process where students receive inspiration and sample ideas concerning how to create a PowerPoint, how it can be used, and which other activities can be incorporated to facilitate communication. Students work steadily to perfect and remodel their presentations. Some students begin work on their presentations at an early stage and use a considerable amount of time on them: in several cases, students work for a number of days. They enjoy working on their presentations and exhibit great energy. In other words, the project concept invites students to immerse themselves in their chosen topic and to spend time working with it. They experiment with their presentations and want to do well and get a positive response. (Sørensen 2009)

Summary of cases

In the cases outlined above, it is clear that it is not only teachers who are able to navigate the three levels Practice, Planning and Reflection in their teaching. Students also use all three levels due to the design for learning which centres on students' learning processes and academic reflections. Based on the cases, an analysis of the three levels is performed (Tab. 1) in relation to the division of the production process in three stages: Introduction, Production and Product/Evaluation.

Production process / **Three levels**	**Introduction**	**Production**	**Product/evaluation**
Practice	Students envisage and describe an assignment and its solution with the requirement that this assignment is relevant to others in terms of subject-specific content. Students plan a multimodal presentation of the assignment.	Students implement and concretize the assignment while discussing the subject-related challenges and methods of multimodal communication with the teacher and their peers. Students test and redesign their assignments.	Classmates provide feedback on the assignments based on the criteria set out by the teacher and on their own appraisals.

Planning	The groups agree on how they will actually organise the assignment so as to be relevant to others in terms of subject-specific content. They discuss what would be a good sequence of activities and good questions to ask. Students agree on how they are going to work together.	Students discuss and try out different ways of constructing and formulating the assignment so as to be meaningful for others.	Students give feedback to classmates. Students address/apply the feedback they receive.
Reflection	Students consider which subject-related topics and combinations to focus on in their assignments.	Students formulate methods for completing their assignments and reflect on how they can be improved based on the subject knowledge they already possess. At this point, many students exceed the specific curricular/learning objectives for the subject for their year group.	Students speak of their understanding of why it is important to listen to and embrace critique. In the dialogue, ideas are created for how everyone can continue the work, and what each individual student needs to focus on in the future.

Table 1: Summarises and illustrates the relationship between the production process and the three levels

Conclusion

The project demonstrates that the specific ICT-related affordenses (interactivity, WYSIWYG-principle, multimodality) exploited in ICT-integrated student productions in conjunction with the developed designs for learning can both facilitate student learning processes and qualify academic learning outcomes. The project has provided experience with and insight into the importance of using students' ICT-integrated production as a base. Moreover, the project has developed and tested tools for organising lessons which are better able to accommodate individual students' learning abilities, learning processes and competences. Ongoing evaluation and sparring allows the teacher to root academic content or to challenge students' competences. When students have the opportunity of working on the basis of their own abilities and levels, they are not hampered by assignments which are either too easy or too difficult for them. Through differentiated learning, students are able to work independently, take the initiative, and be creative and innovative, thereby developing the competences which, from a knowledge society perspective, it is crucial to develop from the earliest stages of schooling. Learning designs, as illustrated by the two cases, give the teacher the time to focus on managing learning processes and organising lessons into different processes, framed by iteration, feedforward and student ownership of the learning processes (Fig. 1).

The vast majority of students were able to produce unique assignments with varied subject matter and an attractive and aesthetic layout. The task of creating productions using multimodal means of expression demonstrated students' academic potential by stimulating and incorporating their powers of imagination. By imagining an assignment which they had to produce, the students learnt the subject-related content while, in many cases, simultaneously learning content exceeding the learning objectives for their year group. The students' multimodal work offered the teacher numerous opportunities for differentiation as learning spaces were established providing students with the room to approach the tasks in various different ways and at different levels.

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