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To Deal With Fluidity in the Networked Society - Self-programming as a Digital Literacy Competence

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Abstract: In the globalized economies e-permeation has become a basic condition in our everyday lives. ICT can no longer be understood solely as artefacts and tools and computer-related literacy are no longer restricted to the ability to operate digital tools for specific purposes. The network society, and therefore also eLearning are characterized by fluidity and the key competence for social actors in this ever changing e-permeated environment is the ability to cope with change - or Castells' conceptualisation *self-programming*. Castells' theory has influenced international definitions of future key competencies. Both lifelong learning and digital literacy understood "bildung" have emerged as central for the definitions of and standards for future key competencies. However, definitions and standards only tell us about the desired destination and outcome of digital competence building. They tell us nothing about how we may get there. In the educational system ICT and e-learning are becoming an everyday condition and the basic challenge for the educational system is twofold: 1) The actually making of digital literate and self-programming social actors – students and teachers; and 2) How to develop adequate designs for teaching and learning for that purpose. We need research that aims to describe the phenomenology of acquiring digital literacy and self-programming in order to be able to identify relevant learning objectives and scaffolding. Findings from such studies are expected to be relevant for eLearning scenarios as well as for ICT and designs for learning in general.

This paper presents a case study that aimed to explore the phenomenological appearance of self-programming as agency and learning among postgraduate students who participated in a specially designed eLearning workshop in the autumn 2009. The findings relate to both the individual and collaborative barriers and proactive strategies that come into play among the students. Drawing on the findings, it is argued that the presented workshop design contributes to the networked society's design for ICT, teaching and learning, as the design – at least for this small group of students – have proved to support the development of digital self-programming as a sustainable competence. In the autumn 2010 the study will be expanded to a larger group of students.

Keywords: Self-programming, lifelong learning, networked society, design for teaching and learning, eLearning

1. Introduction

E-permeation has brought the majority of populations in the globalized economies into an everyday life where ICT is intertwined with almost anything we do in relation to our job, education, public services and society, our friends and family. ICT has become more than artefacts and tools, just as computer-related competencies have become more than the ability to operate digital tools for specific purposes. The structure and organisation of the network society are characterized by fluidity and the basic demand for citizens in this ever changing environment is the ability to cope with change. Consequently, both lifelong learning and digital literacy understood as general education or "bildung" have emerged as central for the definition of future key competencies of the networked society (Tyner 1998, Jewett & Kress 2003, Martin 2006, Katz 2007, Bawden 2008, Levinsen 2009).

Castells (2000) divides employees of the global economy into two dominant types; self-programmable and generic labour. Self-programmable labour is equipped with competencies for lifelong learning, the ability to retrain and to adapt to new conditions and challenges. By contrast, generic labour is both interchangeable and disposable. Castells argue that for a society to remain competitive in the global economy, the educational systems should devote particular efforts to the education of self-programmable individuals. Castells' theory has had major impact on the international definitions of future key competencies used as guidelines for governmental decisions about education (OECD

2001, European Commission 2003, Rychen & Salganik 2003, Elearning Europa 2005, G8 2006). The job market adapts faster than societal institutions and job ads related to network- and knowledge production already display that employers demand self-programmable labour.

However, both the international definitions and the employers demands are product oriented. Descriptions of what it actually means to act as a lifelong learner or a self-programmable individual are rare and questions that seem obvious are never asked, e.g.:

- What do self-programmable individuals do when they self-program?
- How do adults become self-programmable, if they are not?
- How do we ensure that new generations grow up to be self-programmable rather than generic?

It seems as if the formation of key competencies is taken for granted and that the so called *digital natives* are bound to grow up as self-programmable individuals just because their whole life has been e-permeated. This is not what Castells had in mind and during the last decades, a substantial body of constructivist and social constructivist research in the field of teaching and learning has demonstrated that competencies in dealing with complexity are neither inherent nor readymade for use (Sørensen 1999, Sørensen, Olesen & Audon 2001, Buckingham 2003, Malyn-Smith 2004, Breivik 2005, Levinsen 2006, Levinsen 2009). Additionally, research has documented that ICT and learning do not constitute a simple linear determinist or behaviouristic relation. Nevertheless, technological determinism persists as the making of self-programmable individuals for the network society seems to rest on the unspoken assumption that ICT is a natural driver for the learning process.

In Denmark the consequences of almost two decades of strong focus on the objectives of ICT-implementation rather than on the process of continuous and sustainable implementation and adaptation of ICT have recently become documented. Despite the huge investments in implementation of ICT in primary schools, the message is that ICT is not used in relation to the curriculum and a majority of teachers do not integrate ICT in their every day teaching (Levinsen & Sørensen 2008, EVA 2009). In 2009 the Danish government released *New Shared Goals* (UVM 2009) for primary schools where part of the objectives and measures depend on active integration of ICT. Both Levinsen & Sørensen and the EVA-report pinpoint implementation-processes and strategies as pivotal for a successful integration of ICT and both reports identify and describe aspects of the school management's responsibility for nurturing a knowledge sharing organisational culture. Additionally, both reports argue that in-service training has to take on new forms as in this excerpt from the EVA report:

... still necessary to devote particular efforts on the teachers competence building and dedicated support in the everyday practice. The teachers ask for computer literacy courses but they are also aware that former courses did not qualify their teaching practice. The research identifies a need for new models for competence building that aims to integrate ICT in the curriculum subjects and focus on actual use with a contextualised outset in the teachers' concrete needs (Authors translation from EVA 2009, p. 8)

To some degree we can draw on research in *digital natives'* approaches to ICT and learning outside school. However, this research only tells us the characteristics of already self-programming people and how they *do self-programming*. According to the literature self-programming individuals who encounter something new, wonder and ask questions. They experiment and explore to figure out about the unknown. They are open, receptive to input and find it natural to share knowledge and to network. They see and transfer potentials between contexts and they are creative and possess a wide repertoire of strategies to explore the unknown. They have a strong inner drive and motivation to conquer challenges (Sørensen 1999, Oblinger 2003, Malyn-Smith 2004, Dede 2005, Oblinger & Oblinger 2005, Levinsen 2006, Levinsen 2009).

The descriptions tell us about the learning objectives or the outcome of self-programmable competence building, but tell us nothing about how we actually get there. In conclusion, the basic challenge for the society and the educational system is neither the definitions nor the demands but the actually making of self-programmable individuals. We need to know about how to develop designs for teaching and learning that supports self-programmable competence building. In other words, we need research into the phenomenology of learning self-programming in order to describe aspects of the objectives and designs for teaching and learning that supports self-programming competence building.

2. Presenting the case

The paper aims to explore the phenomenological appearance of self-programming among postgraduate students participating in the course *Technology-related Workshop* at the Danish postgraduate programme *Designs for ICT, teaching and Learning*. The course took place over 3 months in the autumn 2009 and the activities were based on group work. The course was subdivided into three separate workshops and the study took place in workshop I. Three students who consider themselves as flexible and experienced lifelong learners with a high level of digital literacy participated in the study:

- Amanda, age 33, primary school teacher – teach visual culture and arts. Additionally, Amanda teaches primary school teachers and adult teachers. She is the author of textbooks in designs for teaching in visual culture and arts.
- Brenda, age 45, special training teacher – works with adult dyslexics and their use of digital support in their study, job and everyday lives.
- Christian, age 26, primary school teacher – teaches ICT and learning practice at the teacher' college and works as technical support at the college.

During a full day in workshop I, the students were presented to an entirely new and therefore unknown digital prototype named *Topobo* from MIT media Lab (Raffle, Parkes, & Ishii 2004). They were just given the cardboard box containing the prototype and asked to explore the content and figure out how it worked and how it may be used for learning. The students were instructed to produce individual logs on their approach with special attention to questions like:

- How do I act in order to explore?
- When do I prefer to collaborate or explore on my own?
- What obstacles do I encounter and how do I act on them?
- What helps me to bypass obstacles?
- Do I change strategy during the day?

Further they were asked to write their immediate reflections at the end of the day and reflect on the prototypes potentials for supporting learning. For assessment of the course, the students used their e-portfolio and wrote 3-4 pages reflection papers and presented their individual experiences, reflections and learning on the last day of workshop I. For research purpose, the session was video recorded with two cameras: One stationary camera covering the total and a handheld camera for close ups. The recordings were made accessible for the students work on their reflection paper. The students written material constitute the research data together with the video recordings.

2.1 Analytical tools – making learning visible

In order to make learning visible and shareable, and in order to scaffold the students' 2. order reflection on their performance regarding strategies and attitudes when introduced to something unknown, they were introduced to a theoretical toolbox. From a phenomenological research perspective the toolbox supports the researcher's insight into the first person perspective of the students. For this double purpose Castells' theory of the networked society (2000), Everett Rogers

theory of diffusion of innovation (1985) and Dreyfus & Dreyfus' Model of Skill Acquisition (1988) were chosen.

2.1.1 Informal vs formal approach and the adoption of novelties

The self-programmable and generic individuals that are described previously, offers a tool to reflect on whether encountering something unknown generates personal initiatives or a need for teaching.

2.1.2 Inner motivation and the adoption of novelties

Rogers' widely recognized Diffusion of Innovation Theory deals with how, why, and at what rate new ideas and technology are adopted by populations. Rogers defines diffusion as *"the process by which an innovation is communicated through certain channels over time among the members of a social system"* (1995, p. 5). According to Rogers, a population is subdivided into five categories depending on their approach and willingness to adopt novelties and the distribution across the categories corresponds with the normal distribution.

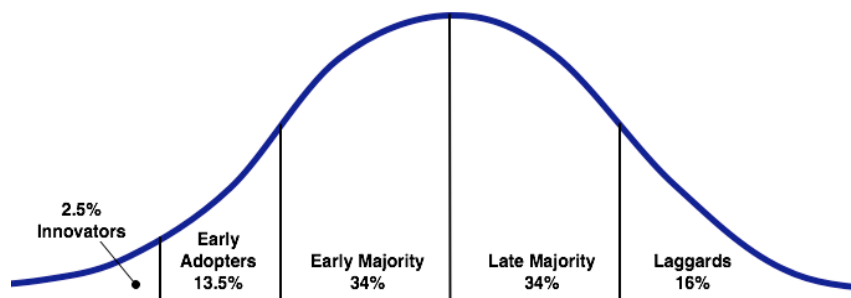


Figure 1: Rogers' Diffusion of Innovation Curve (after Rogers 1995)

Innovators (2.5%) always explore something new, no matter if it becomes mainstream or not. Early Adopters (13.5%) wait for the innovators to do the initial work and adopt anything that appears to be useful. Rogers describe Innovators and Early Adopters as individuals who possess an inner motivation to explore and adopt novelties and accordingly they resemble Castells' self-programmers. Early Majority (34%) adopts something new if it becomes popular among the Early Adopters. Once the Early Majority accepts a novelty, it becomes mainstream. Late Majority Adopters (34%) accepts a novelty because they are expected to follow the general trends of society. They adopt the new because they have to. The last group are the Laggards (16%) who will go to lengths to avoid anything new. Early and Late Majority have to get used to something new and they need to see a purpose. For the Early Majority Adopters the purpose may be a potential they wish to exploit, while Late Majority Adopters accept the new on the basis of a personal cost-benefit-analysis. The fastest Early Majority Adopters may be described as self-programmers while the rest together with Late Majority Adopters and Laggards resembles generic labour as they demand instruction in order to acquire and adopt the new (Levinson & Sørensen 2008, EVA 2009).

According to Rogers, a person does not belong to the same category in all aspects of life and may move between categories. The speed of adoption also differs considerably depending on how radical changes the innovation implies in the life of the single adopter or adopting organisation. E.g. WAP-technology did not catch on while mobile technology spread throughout groups including the laggards in a few years. With this in mind, Rogers' theory offers a description of aspects of an adopters' attitude towards innovations that may function as a tool for self-evaluation of the strength of one's inner motivation for exploring the unknown.

2.1.3 Competence for exploring the unknown

In contrast to Rogers' theory, Dreyfus and Dreyfus (1988) asked which performative appearances that distinguish and define the extremes novice and expert and the intermediate positions. The Dreyfus

brothers studied the practice of chess players and nurses. That is, disciplines that combines formal and informal competencies in terms of rational thinking, profession skills and experiential knowledge construction. Based on the research and Piaget's constructivist theory they formulated a five stage *Model of Skill Acquisition*, where each stage describes the phenomenological characteristics of learning strategies for developing expertise.

The novice performs trial-and-error strategies without reflection. The advanced beginner depends on rules but reflects within learning-by-doing strategies. The competent may act independent and deliberately plan and change strategies. However, the competent does not question the basic assumptions. In Piagetian terms, novices, advanced beginners and competents assimilate and accumulate new knowledge. They are - to various degrees - dependent on rules and instruction and they prefer to react rather than to proact. In this sense they resemble generic labour and slow adopters. In contrast, proficient and experts act independent, reflective and proactive. The proficient questions basic assumptions and might radically change strategy due to reflection and experience while the expert deals with challenges by intuitively drawing on tacit knowledge and thought experiments in a fluid performance of Reflection in Action (Polanyi 1968, Schön 1983). In Piagetian terms the proficient and experts accommodate new knowledge as they (re)arrange and (re)construct basic assumptions and strategies in radical ways. Therefore they resemble self-programmers or Innovators and Early Adopters. The Model of Skill Acquisition offers a tool to describe how competent one finds ones personal strategies for exploring the unknown to be.

2.2 The content of the cardboard box

Topobo is the world's first construction toy with *kinetic memory* = the ability to record and playback physical motion. It is developed by MIT Media Lab's Tangible Media Group (Raffle, Parkes & Ishii 2004).

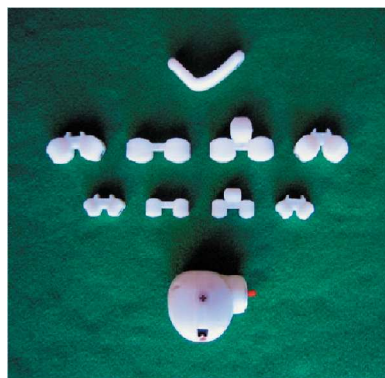


Figure 2: Topobo building elements

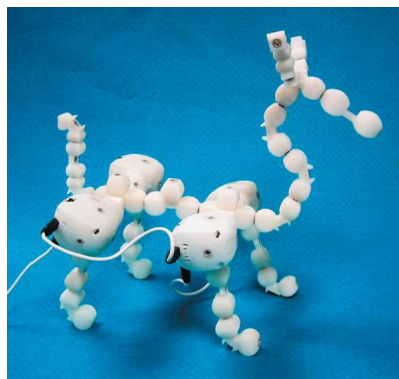


Figure 3: An animal creation assembled with Topobo building elements

The prototype consists of passive and active (motorized) components. By snapping together passive and active components, it is possible to assemble dynamic biomorphic forms like animals and skeletons. The system is programmed for movements through direct manipulation of the actives: pulling, pushing and twisting. Apart from individually programmed actives, Topobo also has special actives called "Queens" that control an entire network of individually programmed actives, thus allowing a variety of combinations. After recording movements into the kinetic memory, the user may observe how the assembled construction moves and explore and experiment with complex constructions and movements.

3. Self-programming in practice - The students' first person perspective

In this section the students' reflections and learning are presented in a condensed form based on their first person perspective in the written immediate impressions, e-portfolio and reflection papers from the course. When working with their e-portfolio and the reflection paper, the students also had access to and actively used the video recordings from the activity.

3.1 Amanda

Amanda was surprised by her reactions. She had expected to act as an Early Adopter according to Rogers. Instead she acted as an Early Majority adopter. In the reflection paper she describes her approach as: *I was open for the new but approached it in a formalized way. I did not expect anything to work.* Amanda had also expected to self-programme on a competent level according to Dreyfus & Dreyfus and found to her surprise that she acted as a novice. She describes how she mimics the other two students or plays around a random in a trial-and-error strategy rather than to reflect on her experience and ask explorative questions. Amanda admits to herself after having struggled, that her dominant barrier is impatience that produces a feeling of frustration over the fact, that she is not immediately able to grasp Topobo. Later in workshop I, Amanda decides to exploit her new gained awareness of her strategies to actively improve her self-programming competence. She decides to develop a learning object in Google Maps which is a new application for her. She experiments with ways of posing questions in order to diagnose challenges rather than face obstacles. Amanda concludes that in order to work with her self-programming competence, the task must be relevant and concrete. She also stresses the importance of individual working space along with collaboration and knowledge sharing.

3.2 Brenda

Brenda acts in accordance with her own notion of being Late Majority and lets the others take the lead. She only scratches the surface and plays around with Topobo elements at random. However, looking at the video she realizes that when she suggests something she often drives the collaborative learning process forward. E.g. she is the one to understand the difference between the actives and the "Queen" by just watching the others. Referring to the video Brenda writes: *The teacher (the author) mentioned my suggestions and that my approach seems to be intellectual – that is not at all how I see myself! But the elements sounded like an electromotor and the different colours seemed to behave different. They reminded me about serial- and parallel connections in electric systems in school. I never understood those connections before.* To her surprise she finds herself to be a good observer who reflects and suggests changes in the shared strategy of exploration at Dreyfus & Dreyfus' levels competent and proficient. In the concrete situation the teacher's comment provokes Brenda to change her approach and begins to manipulate the components herself and she invents small experiments that systematically explore gravity and motion in order to construct a forward moving crap together with Amanda. In her professional life Brenda introduces digital support for dyslexic students and helps them to implement the support in their study practice. In the reflection paper she writes that she expects the awareness of her own learning process towards approaching something new, may improve her openness towards dyslexic students' position and reactions regarding the digital support.

3.3 Christian

Before the cardboard box is opened Christian describes himself as an Innovator who likes to fiddle with new gadgets and he expects his approach to self-programming to be proficient according to Dreyfus & Dreyfus. However, he experiences to get stuck with Topobo and ends up in eternal circles of trial-and-error with no progress. In the reflection paper he mentions Brenda's suggestions as a personal turning point that inspired him to change strategy and mimic Brenda: *... I left fiddling to the others and began to suggest new procedures and solutions. I found that it is easier to reflect and modify my understanding if I do not always place myself in the first row and fiddle with things.* Later when he looks at the video, he sees how he literally takes things out Amanda's hands. Thus, his urge to fiddle is a barrier not only for himself but also for others. In the next phases of the workshop Christian decides to change his strategy and mix fiddling and reflection in a combination of individual work and collaborative knowledge sharing. He finds this new insight to be important in his professional work as a pedagogical ICT supporter.

4. Discussion

The three students individually conclude in their reflection papers, that the workshops design for learning pushes them to reflect on their strategies and patterns when introduced to something new. The experience impact on their awareness of self-programming competence building and they find they have improved regarding conscious awareness and the ability to evaluate the appropriateness of a chosen strategy. During the day with Topobo, the students consciously begin to modify their strategies. At the end of the entire module, the impact of change is present and articulated by the students in their final and externally evaluated module assignments. Brenda and Christian claim a direct transfer of learning to their professional jobs while Amanda experience transfer of learning when she confronts herself with new technological challenges as Google Maps and later other technologies.

From the research point of view, the changes in the students' behaviour can be interpreted as a movement from a single-strand to a multi-strand strategy. In the beginning the students display the following strategies:

- Amanda is a fiddler but needs a clear purpose or idea before she can manage to reflect on and learn from her hands-on experiences. According to Rogers, Amanda is an Early Majority Adopter and her self-programming approach matches Dreyfus & Dreyfus' novice level.
- Brenda observes and avoids fiddling. She pushes the responsibility of action away from herself and acts as Rogers' Late Majority as she rarely explores anything entirely new. However, her intellectual self-programming approach matches Dreyfus & Dreyfus' competent to proficient levels.
- Christian is a fiddler and attacks any gadget that comes his way. He is obviously an Innovator when it comes to technology. However he is at Dreyfus' and Dreyfus' novice level when it comes to self-programming.

The strategies are all single-stranded; they either fiddle (Amanda, Christian) or reflect (Brenda). When the students reflect on their actions and attitudes, they find that although their preferred strategy seems to work, they all encounter impenetrable barriers. In their efforts to pass the barriers, the three students individually realize that fiddling has to be combined with reflection and they gradually move towards multi-strand approaches. In acquiring a multi-strand approach the students gradually become able to consciously change the basic assumptions about Topobo and accordingly their strategies towards Topobo. That is, they move their competence level of self-programming towards the proficient level.

In the process of becoming aware of self-programming competence building as a personal learning process, Topobo seems to play two parts. In the individual space the student gradually figures out about Topobo and becomes aware of self-programming – that is learning as a process becomes

observable and thereby also an object of change for the student. Topobo can be said to support a cycle of internalization of what is outside, and externalization of what is inside the mind of the single student. This process corresponds with Seymour Papert's ideas of constructionism (Papert 1990, p. 3). In the collaborative space the externalized ideas that materialize in specific Topobo constructions function as a boundary object (Wenger 2000). The materialized construction represents an inexpressible idea or tacit knowledge (Polanyi 1968) as Brenda's sudden flash back to serial- and parallel connections in electric systems. In this sense, the construction as a boundary object becomes a non-verbal language that supports a shared negotiation of meaning and a shared re-arrangement of materiality. During this process the students becomes aware of how their strategies either promote or hamper the shared exploration of Topobo.

Gradually, the multi-strand strategies come closer to a *bricoleur-strategy*. According to Turkle and Papert a *bricoleur* approaches challenges by connecting practice and concrete thinking in an intertwined process of arrangement and re-arrangement of materiality while constantly negotiating and re-negotiating meaning (Turkle & Papert 1990, pp. 129). This is in accordance with Amanda and Christian who both stresses the need for individual space together with a collaborative and social space for learning. In contrast, Brenda primarily stresses the collaborative space as she prefers to be instructed either in a formal context or by fellow students. This finding is important, as a dominant trend in current and future oriented designs for teaching and learning tend to emphasize collaboration and social learning at the expense of the individual learning space.

In the reflection papers, the students individually conclude that self-programming competence building must evolve round a task with a meaningful outcome. However, *meaningful* means something different depending on the students' willingness to explore and adopt new technology. This is an important finding regarding how to design for self-programming competence building, as "on-size-fitt's-all"-design may prove to be insufficient. For Christian as an Innovator it is meaningful to explore out of pure curiosity, while Amanda as an Early Majority Adopter explores technology when she has seen examples of use that inspires her to imagine learning potentials in her own field. Brenda as a Late Majority Adopter only explores new technology when she is forced to do so. However, during the workshop she gradually becomes an Early Majority Adopter..

The findings from the case study are both related to the individual and collaborative barriers and emerging proactive strategies that come into play. Drawing on these findings, it is argued that the presented Topobo-session design contributes to the networked society's design for teaching and learning, as the design – at least for this small group of students - supports their development of self programming as a sustainable competence. In the autumn 2010 the study will be expanded to a larger group of students.

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