Professionshøjskolen UCC

WORKING PAPER

Understanding and developing "Technological Literacy" through Living Labs in teacher vocational education

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Overview of the Technucation Project

Technucation: Technological Literacy and New Employee Driven Innovation through Education is a four-year research project funded by the Danish Council for Strategic Research. Through a qualitative study of 75 interviews with teachers and field observations in 10 schools, the aim is to examine how new technological innovations change teachers' working practices and understanding of their own profession.

In the world of education—teaching and learning—new digital technologies are apparently inevitable. We regard them as active participants in the education process, affecting the learning environment and even setting an agenda for what goes on in the classroom. From this perspective, it is advisable for teachers to combine their longstanding familiarity with children's learning processes with their still-emerging knowledge of technology. The resulting competence, knowledge, and skill is covered by the term *Technological Literacy*. Technological Literacy designates a new mode of interaction with technology, which enables teachers to find a balance between their use of technology, the content of their teaching, and their pupils' ways of learning.

As stated above, teachers' working practices must change in response to the implementation of new digital technologies. These new artifacts have already created new conditions for education and new learning possibilities for the children. It is necessary to point out, however, that the changes that have occurred already following the introduction of new digital technologies were not planned or predicted; there was little training involved. This is because what took place was not an anticipated development, but simply a change that occurred when Denmark's regional governments decided to invest in new digital technologies for the schools. Teachers then started using the new technologies, and developed their own ways of getting the lessons to run smoothly, bearing in mind their pupils' familiarity with and use of the technologies at issue.

These developments and changes in the classroom clearly ought to be reflected in the curricula of teacher training colleges. Unfortunately, it is evident that Denmark's teacher training colleges are not up to date when it comes to technological-pedagogical innovations. One of the Technucation Project's main challenges is, therefore, to transmit knowledge gained in everyday practice in the country's schools to the teacher training colleges in a form that can foster curiosity, dialogue, and learning with regard to working and interacting with technologies.

The focus of this paper is on the part of the Technucation Project that centers on challenging what *Technological Literacy* is and means in a Danish teacher-training context, and enriching the learning environment of Denmark's teacher training colleges with actual everyday working practices involving technology. The goal of the Technucation Project is to create a new learning tool and didactic model for use in teacher training, with Living Labs as a primary mode of action. Living Labs are designed to involve teachers from schools, Technucation Project researchers, and student-teachers and lecturers from teacher training colleges in a joint process of developing and understanding the importance of new technological innovations in the working practices of Denmark's teachers.

Teachers and Technological Literacy

The Technucation Project runs from 2011-2015. Part of the pilot study consists of 14 interviews with teachers. With these as background, Vibeke Schrøder, in collaboration with Ann-Thérese Arstorp, analyzed the kinds of technological literacy that the teachers ascribed to themselves when describing their work with concrete examples of everyday practice. The result of this analysis is an account of each teacher's perceived technological literacy through four perspectives on technology;

1. An intuitive perspective on the use of technology
2. A hesitant perspective on the use of technology
3. An integrating perspective on the use of technology
4. An efficiency-improving perspective on technology

These four perspectives emerged as salient discourses in the interviews, at points in which the teachers spoke about their different ways of using technology in their work, and how they experience and understand the use of technology.

In the first perspective (the intuitive one), technology is regarded as having a natural and inevitable position as a learning tool in the classroom. In this perspective it is considered part of a teacher's role, as part of his or her didactic practice, to decide when to use any of a broad range of technologies and when not to.

The second perspective (the hesitant one) experiences technology as something that is often unavailable or unreliable, e.g., by breaking down. This makes it difficult for the teacher to develop his or her technological competences, as for various reasons they are not in play.

In the third perspective (the integrating one) the teacher simply adds the new technology to his or her ordinary didactic practice, so that it becomes an appendix to it. The technology simply adds a new way of doing the same thing.

In the last perspective on technology (the efficiency-improving one), teachers express how technologies offer them relief in their work, not only when it comes to more administrative and communicative tasks (e.g. collaboration with the parents), but also in regard to handling, saving, and sharing knowledge (e.g. sharing among teachers, or saving work that has already been executed by the pupils). Last but not least, this perspective also covers reports of greater participation and motivation by pupils when technology is involved in the classroom.

These perspectives are tentative, and are not drawn from any teachers in particular. Often more than one perspective is represented in a single teacher's way of talking about technology. The question of the perception of technology in the schools is thus not just a matter of the teacher's competencies in handling and using technology (as the question of implementation and use of technology has traditionally been discussed). It is, rather, a more complex matter involving how technology is *perceived* by the individual teacher and used accordingly. Hammond, Reynolds, and Ingram (2011), who situate themselves in the traditional discussion of teacher competence with regard to technology, have created three levels of technological competence—routine, extended, and innovative—based on an empirical study of student teachers during their traineeship. Garmire and Person (2006) similarly operate by classifying individual competence in technological understanding using of three parameters (not levels), namely knowledge, capabilities, and critical thinking and decision making.

Our list of four tentative and flexible perspectives on technology indicates how the handling of technology happens within a situated context, and so cannot be expressed merely by evaluating a teacher's individual competences. The various ways of handling and using technology instead indicate how the individual teacher acts within the specific cultural, social and technological condi-

tions that help shape his or her actual practice. Instead of understanding competence as something that can be improved in a taxonomic sense, we understand it as something that is linked to a specific situated context. The handling and use of technologies therefore involves not only the teacher and the technology, but also the situation as a whole, including the pupils. The different perspectives are all a part of a teacher's professional identity, and can become objects of verbalization—and perhaps also learning, once they are understood as being situated in a specific context.

In this area of tension between professional practice and social context, the technology at issue is obviously an active participator in forming the teacher's professional identity. Professor Cathrine Hasse, leader of the Technucation Project, has remarked in this context that is remains a question "whether a professional expertise (Edwards 2010) makes a professional act consciously intentional in relation to technologies, or if it is the technologies that create the intentions?" (Hasse 2012).

Technologies as active agents

Another analysis of the empirical material from the Technucation Project's pilot study focuses on how technologies form the teacher's perception of *time*, and more generally on how *time* changes in the classroom context when new interactive whiteboards, computers and other digital technologies are implemented. It emerges that the way in which teachers use new technology, and the way in which new technologies influence what goes on the classroom, function in turn to create new perceptions of time. A new form of *digital time* challenges the school's existing linear and circular perception of time, in which the *present* is controlled by the school's activity. *Digital time*, by contrast, brings with it new working methods that are both more fragmented and more dynamic, such as ,. With the new digital technologies, *time* in schools acquires a more elastic and changing character.

In certain situations, technology can take time away from the educational task, and can act as a drain on the little time that teachers seem to think they have with their pupils. Some teachers experience technologies as *disruptive artifacts* in both a negative and a positive sense. Disruptions can make time "stand still" in the classroom, as when a teacher's lesson plan gets interrupted (e.g., by a breakdown in technology), and therefore creates waiting time for the pupils. On the other hand, the use of technology sometimes seems to make everything go faster, so that time seems more efficient and compressed (e.g., it is faster to find information when using the internet to do so). The teacher spends less time writing on the blackboard, and navigates with ease to information and materials from different Internet platforms and portals. When digital technologies are disruptive in this *positive* way—positive from the teacher's perspective—they free up time, so that more can be accomplished per lesson than would have been possible without technology. Here technology is clearly regarded as an active agent in the classroom, and as partially responsible for establishing the framework for what goes on in the teaching context. It influences not only the way the

teacher prepares for a lesson, but also how the lesson is executed (Schraube 2009, Sørensen 2009, Jensen et al 2010).

The pupils use technologies in unexpected ways, because the technologies themselves encourage them to interact with them in ways that might be disturbing (e.g. using Facebook). These actions force the teacher to continue the lesson in a different way than originally planned. From a teacher's point of view technologies are dynamic, challenging and uncontrollable. Some teachers feel a certain loss of control in the presence of technology, whereas others see it as a challenge that helps create more movement, activity and flow in a lesson (Jensen 2010). You click, press, type, and search the Internet and thus push the limits of the classroom.

What ultimately goes on in the classroom is the product of a complex intermingling of traditional learning tools and new, technology-driven working practices. Nevertheless, there remains an obvious contrast between a *linear* and *circular* perception of time (a school day, a schedule, a lesson), connected to the rhythmic, repetitive, and progressive way of understanding teaching in relation to time, and a *digital* perception of time, in which the teacher's work is more fragmented, is continually in the present, and is directly connected to the world outside of school. Technologies influence the school's domain, both in regard to how time and the limits of the school are perceived. In this way, the presence of technology in the classroom poses a challenge to both the work and the professional identity of the teacher.

From qualitative data to a prototype of a learning tool

The above analyses of teacher-perceived Technological Literacy and of the way in which technology functions as an active agent are both examples of findings generated by qualitative studies of the data gathered in the Technucation Project. The insights and knowledge gained from the Project's empirical research and field observations are then to be deployed in the service of its educational task. In other words, one of the primary purposes of this research is to contribute to the quality of the teaching of Technological Literacy in Denmark's teacher training colleges.

The aim is therefore to develop an application-oriented learning tool that can be implemented and used in teacher training. The quality of the tool is secured by its roots in the local community, by its responsiveness to empirical research in the teacher training profession, and by the participatory and inclusive process by which it was developed in detail. This process involved the participation of several different partners from within the relevant professions and teacher training colleges.

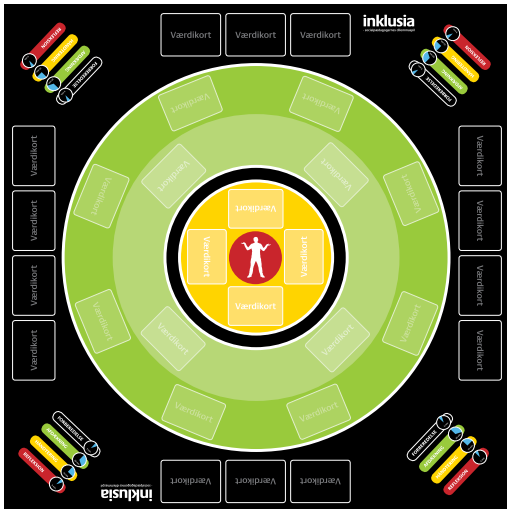
The learning tool was developed through a pre-planned process of development, based on the creation of a prototype. Our specifications for the prototype derived from analyses of the empirical data from our qualitative studies.

The prototypes, therefore, are the basis of the actual learning tool. Its main purpose is to prompt lecturers, teachers, and student teachers all to reflect on their own *hands-on experiences* with technology. This should give them an idea of how the relevant human relationships (e.g. teacher-student, teacher-parents) are transformed when technology is involved (Plomp et al. 2010). The intention of the learning tool is therefore to give the lecturers and student teachers a collective experience and shared understanding when it comes to handling and using technology. They will need to learn how to collaborate on developing a connection between traditional and new technologies in the classroom con-

text, and to discuss the significance of technologies for general development in the schools and school-systems. A primer in the historical significance of technologies for teaching and learning is therefore included in the learning tool. The learning tool is still a work in progress, but it is thought to consist of various didactic tasks and cases, which offer insight into the impact of technology on professional practice. Discussion of these cases should help draw attention to both formal and informal learning environments, and should help participants to see the benefits and disadvantages of technological use for pupils' learning-possibilities.

One example of a prototype: a game of dilemmas

One of the prototypes that we have been working on is a board game. The purpose of the game is to contribute to discussion and debate about the use of technology in the classroom by introducing a series of case stories representing various professional dilemmas. The students (or soon-to-be teachers) must then discuss, in groups, the various values and perceptions of technological and pedagogical issues that have bearing on each case. Throughout the game, they must narrow down the values and professional conditions that they consider the most dominant, by discussing the cases and by arguing on behalf of their own perception of the case.



- The prototype, inspired by the game Inklusia.

The cases are derived from empirical material drawn from both the pilot and the second round of interviews in the Technucation Project. The rules of the game are as follows: four students sit around a game board and discuss the case story. The first stage is a process of clarification, in which the students collaborate in trying to figure out what kind of a situation they are dealing with.

Second, the students start to discuss what dilemmas (particularly technology-related ones) are present in the case. Third, the students must discuss a plan of action. How should they respond to the given situation? What to do? How to act? Finally, they must reflect on how the case contributes to an understanding of the complexity of working with technology in a classroom context.

Working as a teacher means needing to comprehend situations and act quickly, which is why the students are forced to choose (through a sequential process of "clarification—discussion of dilemmas—action") how they would handle the situation described in the case.

Example of a case: Educating math, using a computer

In a 7th grade classroom, a young teacher by the name of Thomas is getting ready to teach math. He asks all of his pupils to find their computers and notebooks. Today they are working with a program called *GeoGebra*, doing tasks with a virtual compass. Thomas uses the interactive whiteboard to show how to draw using the virtual compass, and how to set it precisely.

The pupils now have their computers turned on, and have located *GeoGebra*. Three girls, however, do not have their computers with them. They settle for using their notebooks and an old school manual compass. The three girls start to chat and talk condescendingly about Thomas and the fact that he always uses the interactive whiteboard when teaching. They think he is too smart, and have a hard time understanding why they must use the computer when they much rather would do the task by hand.

The purpose of the game is to get the student-teachers to consider the didactical consequences of using (or not using) the technology at issue. When and how should the technology be used? What is the purpose of the lesson or the task? Is it learning to become skillful at using a compass; understanding what a compass can do; understanding how to use a compass in a computer software program; or learning to use technology as a part of working with mathematical related tasks? Are there several purposes? Is one purpose more important than another? How is the learning environment designed in relation to the use of technology? How can one use (or not use) the girls' critique in a constructive manner?

The value-cards (with values like: freedom, trust, obligation, professionalism, dignity and loyalty) are created to help add nuance to the discussion of how to understand the case story and the dilemmas it involves. Each group of students receives a stack of value-cards and a couple of blank *write-your-own-value-cards*, in order to help open up discussion of the case-story and create a frame for discussion.

With respect to the requirements that the final learning tool must fulfill, this prototype is particularly useful in fostering an environment in which insight into and discussion of the consequences of implementing new technology can emerge. The game helps create a common language for talking about technology and didactics in relation to each other, and creates shared collective experiences through the act of reflecting on the case stories. On the other hand, the prototype falls short when it comes to incorporating hands-on experience with technology, and or knowledge about how a given technology technically works.

This prototype has been tested on the group of researchers from the Technucation Project. One of the biggest challenges we faced was the fact that we tended to focus on general pedagogical dilemmas rather than on technological dilemmas. In other words, it was difficult to create a discourse in which both pedagogy and technology came together. For this reason, we are continuing to test and develop the prototype, and will do so continuously until it can be called an actual learning tool. Through two upcoming Living Labs (in November 2012 and March 2013), the prototype will again be tested, this time by lecturers and students from teacher training colleges, so that we will end with a fully professional and usable learning tool.

The Living Lab methodology

Over the course of the Technucation Project, several different laboratory methods have been used in developing and testing the prototypes. The first "Lab" held was an Innovation Lab. The purpose was to invent the very first prototypes, and secondly to test these first-edition learning tools, by appealing to the individual experiences of the Innovation Lab's participants (lecturers, teachers from schools, student-teachers, and researchers from the Technucation Project).

To refine the prototype and point the way forward for the final learning tool, two Living Labs will be held to test the prototypes and discuss constructive changes that need to be made. Then a third Living Lab will be held as a test of the final learning tool, in a set-up as close to a real life setting as possible. The last element in the process will be to undertake a quantitative survey on a large group of students, to evaluate the tool's pedagogical efficacy.

The different laboratory methods used are connected to various innovation strategies that have been developed for product development in a market context. This is closely connected to the globalization paradigm introduced in the beginning of the 1990s. The first Living Labs were initiated by MIT (Massachusetts Institute of Technology) for the development of ICT (Information and Communications Technology). The idea was to create products through participatory processes, namely, by involving the products' prospective users or consumers in the process of development so that they would emerge from development having already been tested. All tests were carried out in so-called "real life settings," namely, settings as close as possible to the one in which the technology was being developed to be used. The Living Lab methodology has the reputation of being both empowering to users, on the one hand, and a savvy use of research and development funds, on the other, inasmuch as it leads to increased profitability (Eriksson 2005, Peltomäki 2009).

The first Living Lab in the Technucation Project will be held in November 2012. Over the course of two days, a group of lecturers and student-teachers from the teacher training colleges will test one or two prototypes. On the first day of the Lab, the lecturers and researchers from the Technucation Project will work together to ensure that the lecturers become familiar with the prototypes, take them into their own hands, and make them their own. On the second day, a group of student-teachers will be taught and tested by the lecturers, using the prototype as an actual learning tool. The course of events will be documented on video and finally evaluated through group interviews.

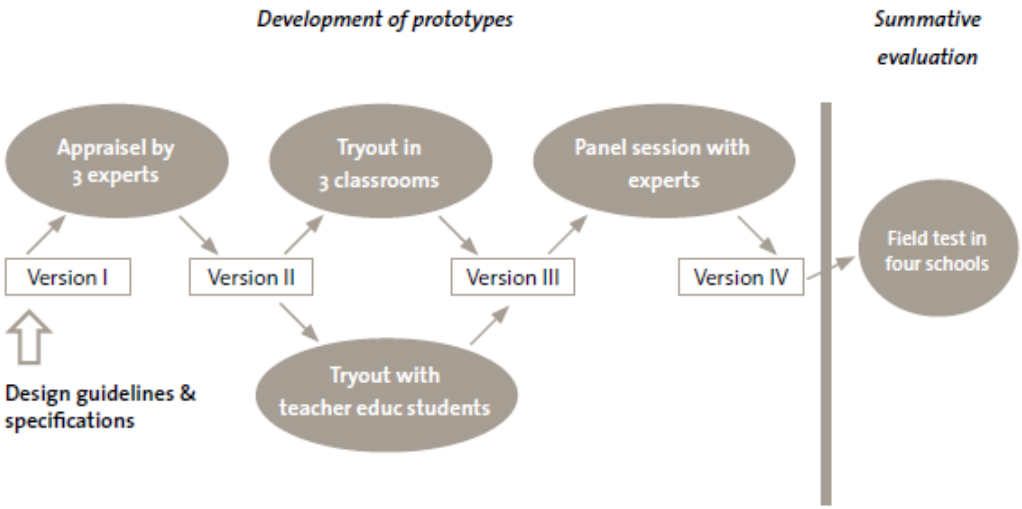


Figure 8: Example of research research design (adapted from Mafumiko, 2006)

(Plomp et al 2007)

The above model by Plomp et al. illustrates a project layout similar to that of the Technucation Project. The idea is that proto-

types are to be tested continuously in Living Labs and real-life settings, with repeated adjustment before final testing in the teacher training colleges takes place. The Living Lab method is set up to look like the reality it is being used in, in the end; but it must still be able to capture the knowledge and experiences created in the process. One of the challenges for the Technucation Project, therefore, is to produce not only knowledge about a "product," but also knowledge about the teaching potentialities of the tool itself.

Pedagogical implications

As is no doubt implicit throughout this paper, the Technucation Project is a highly strategic research program whose goal is to create a definition of Technological Literacy that embraces both the understanding that exists in the educational institutions and the understanding that has emerged in the profession itself. In this context, the project distinguishes Technological Literacy from knowledge *about* technology, where knowledge is understood as locally anchored practical knowledge, while the comprehensive perspective implies reflection on relations between relations. Such a differentiation can also be transferred to a distinction between what Bourdieu terms as a practical and symbolic mastery (Bourdieu 1977). A way of handling technology that does not take the technology for granted, but instead takes account of its agency and works with it both didactically and pedagogically. This intention is written into the specifications for the prototype, as a demand for developing a tool that offers insight into the consequences of the use of technologies in a practice, creates an awareness of the relations between technology and humans, and finally creates an opportunity to work on the formal and informal learning environments that arise when using technology in the classroom.

This raises two further questions. First of all, can knowledge created through the Living Lab method be made productive within an institutional educational context, where the goal is to change a professional-technological practice? Second, what does it mean for the production of knowledge that it is guided by a method used to correct the production of a product within a market context? The first question will be discussed further with the aid of Anne Edwards' (2010) work on the ongoing development of a professional practice. The second will be addressed by outlining the fundamental differences between the Living Lab method, on the one hand, and on the other hand action research, which is a more traditional way of linking research to a practice.

The Living Lab method focuses on tangible prototypes, with the aim of concrete learning about the profession's technological practices. But knowledge in a professional context is tied together with the organization as a social unit, i.e., as constituted by social norms, expectations, institutional practice, and the possibilities they create for action. Action is here understood within a cultural and historical perspective (Edwards 2010). Anne Edwards uses Marianne Hedegaard's (2009) cultural-historical model on analytical levels in relation to understanding a professional practice. She adds *knowledge* as one of the conditions for actions:

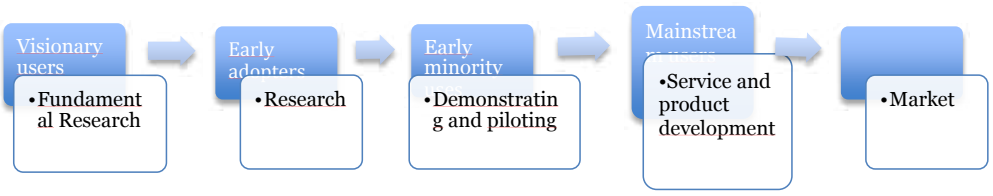
Levels of analysis:

Society	Tradition	Conditions
Institution	Practice	Value/Motive objects, *knowledge*
Activity setting	Social situation of Development	Motivation
Person	Activity	Motives/Engagement/Intentions

On this model, the Living Lab can be seen as a valuable methodology for illuminating the professional practice and professional knowledge of individuals with their particular activities, motivations, and intentions; but it is more questionable as a method of analyzing social aspects of professional practice, or of understanding a practice that unfolds within a complex institutional frame. The outcome of the Living Labs can be evaluated in a more nuanced fashion by drawing an analytical differentiation between, on the one hand, the Living Lab as social and didactical process in the real-life setting of teacher training, and, on the other hand, Living Labs as a way of developing an artifact to be used in teacher training education. Put tentatively, the processes of testing the prototype appear to be of more use in influencing practice than the learning tool itself will be.

At the level of the State and the institution, the Living Lab methodology does not offer much insight. A classical institutional analysis would describe educational institutions as relatively autonomic entities. On the other hand, the methodology might depict the fact that schools and education are highly permeable in relation to the surrounding society with respect to market and policy mechanisms. The Living Lab methodology can contribute by providing a space in which (technological) practice can be explored in new ways in the field of education.

Here is the action space of the Living Lab:



To clarify the participatory and inclusive objective of the Living Lab methodology, we may compare it to action research, a well-known research strategy that also involves the relevant actors in the developing process. In the various phases of action research, the problem of interest is defined as one of collaboration between the researchers and the professional. The actors describe different utopias that can ameliorate or even solve the problem of interest. They then work together to start an unfolding process that will meet their needs (Paaby 1988, Nielsen 2006).

There is one difference, however. In the Living Labs, the scientific question of interest (the problem) is decided beforehand. The object of research for the Technucation Project is a given one: handling and understanding technology in a classroom context. Thus technology is simply not a focus chosen organically by the participants in the Living Lab. Instead, it is decided for them that this will be the object of interest. As described in the intro-

duction to this paper, technologies are often introduced because of policy and/or executive decisions that are made on a regional level. In other words, the implementation of technologies in the schools is a top-down decision, on which the teachers have little to no influence. The Living Lab methodology can create a frame for critical professional thinking about this decision, and secondly a (hopefully) constructive response to the challenges that schools are facing in regard to technology.

Conclusion

The Living Lab methodology mediates the traditional institutional autonomy of the Danish school system with new influences (e.g., the implementation of technology) decided by public policy and market trends. Living Labs do offer some measure of empowerment and influence, while still emphasizing the traditional Danish ideal of "Bildung" in the school system. Living Labs can be looked upon as a pedagogical Exploratorium, inasmuch as they give teachers from schools, lecturers and student teachers an opportunity to develop a space for critical professional thinking, by inviting them to reflect critically on—in this case—how technologies influence a teacher's work and practices. This is a discussion that does not seem to be taking place within the educational institutions as they stand. By adjusting a market-oriented development strategy for a pedagogical and educational setting, the Living Labs here take on a new form and create a kind of "third room" for reflection in and across the boundaries of everyday life. One of the biggest challenges of the Technucation Project will be to find a way to include and embed the knowledge and experience gained from the Living Labs into the common practices of teacher training.

The final question, then, is this: can the Technucation Project develop a learning tool in which all the knowledge and experience gained in the process of development are embedded and taken into consideration? How can we make sure that the learning tool will give prospective teachers a Technological Literacy that will both challenge the professional practice and become a part of it, while retaining focus on the *Bildung* ideal of the Danish school system? The challenge, therefore, is to convey the knowledge and experiences amassed in the everyday practice in the classroom to Denmark's teacher training colleges in a form that will inspire examination, dialogue, and learning.

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