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Digital School Networks: Technology integration as a joint research and development effort

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Schools are increasingly challenged to develop a digital strategy. For some time, digital technology in classrooms has been a topic only for few teachers. Nevertheless, increasingly, it is perceived as a strategic issue for schools that impact the organization more deeply. It not only relates to the deployment of technology and infrastructure and the training of teachers. It also has to address the consequences and potential of technology for curriculum reforms and new instructional methods, which hint at the necessity that digital transformation has been addressed as a larger project of school development.

In order to understand the transformative power of digital technology and the developmental options for schools, a research and development program brings together schools within a geographical region to jointly discuss and develop their digital strategies under the support the university's learning lab.

This chapter describes the rationale of the school-university-community collaborative educational research effort and reflects on the role of the university's learning lab in this development process.

Revisiting the difference between education and research on education

Scholarly studies in the field of education are faced with the expectation of solving current challenges in society. These works relate to various domains of research, such as psychology, sociology or philosophy; they rely on results and methods defined by other disciplines, and still, research in the field of education has to be different than other strands of scientific effort if it wants to meet society's expectations. Ever since education was emancipated from philosophy and established as a discipline of its own, the question was raised how to conceptualize research in education – next to the scholarly disciplines closely related. The inaugural issue of *Educational Review* was first published in 1891 with a paper titled "Is there a science of education?" by Harvard philosopher Josiah Royce (Lagemann 2002). For a long time, educational research had been confined to the idea of "applying" knowledge from other fields to the field of education. Likewise, some researchers follow the logic and methods established in other disciplines, like educational psychology, which, for a long time, had been a somehow successful strategy in the academic world. However, it has become quite obvious that this

approach – despite being successful for the individual researcher – will not be able to contribute to the challenges society is facing in the field of education. Large scale assessments in education such as PISA, have received much public attention and have demonstrated important insights into the state of education in different countries around the world, but they typically fail to provide insights into what changes would be needed and how these changes in education could be achieved (Meyer & Benavot 2013).

In his systems theory of society, Luhmann (1995) describes how modern societies have developed functionally separate – loosely coupled – subsystems (e.g. law, education, health, politics, science) (Weick 1976). The agenda of each subsystem follows a different rationale and it is not obvious how the value created in one subsystem can be transferred beyond its boundaries. Therefore, scientific research essentially has to follow its own agenda if it does not want to be subsumed as a part of the educational subsystem. Following this view of systems theory, we would have to acknowledge an essential difference in the aims and the rationale of the field of education on the one hand and research on education on the other. The implications of Luhmann's view for research on education have been discussed widely. They give reason for a somewhat pessimistic view on the potential of educational research for improving educational practice and contributing to educational reform. Markauskaite, L. & Freebody,P & Irwin, J. (2011) described various approaches that have been developed to overcome the outlined barrier between research and practice in social science, like action research (Groundwater-Smith & Irwin 2011) or design based research (Brown 1992; Sandoval & Bell 2004). Other recent approaches are leaning more towards practice and the analysis of professional expertise, like "scholarship of teaching" (Hutchings & Shulman 1999) and the "teacher as researchers"

movement that relies on a rationale of the practitioner reflecting his/her routines and experiences (Cochran-Smith & Lytle 1999).

The learning lab's approach: joint research and development in digital school networks

At the University of Duisburg-Essen (Germany) the learning lab has been established as a unit for innovation and design based research in the different sectors of education. With its mission "exploring the future of learning" the lab cooperates with various schools in the region of North-Rhine Westphalia to develop new perspectives for learning and teaching with digital media. These projects vividly demonstrate the outlined discrepancy of the aims of the educational practice on the one hand and the aims of educational research on the other hand: Schools need to develop a digital strategy and want to gain knowledge about the implications of digitization for teaching and learning. They want to draw from experiences and results of research, the university can provide from aggregating the state of research in the field of educational technology. Also, schools are interested in the learning lab's expertise in developing and managing change in the field of educational innovations. University, thus, is perceived as a consultant in organizing and accompanying learning processes of educational organizations. It is interested in supporting the innovation process of schools and, at the same time, wants to gain general knowledge on how schools develop digital strategies, how they organize the digital transformation of education and what key factors contribute to success (or failure). Various models and concepts describe the process of integrating digital technology to schools (Davies & West 2014; Hall & Hord 2001; Owston 2007; Petko, D. &Egger, N. & Cantieni, A. & Wespi, B. 2015) that guide the theorizing and the development of hypotheses. A basic question relates to a model of stepwise progression of educational institutions in the adoption of technology from attention to sustainable anchoring.

The “NMC Horizon Report” by Freeman, A. & Adams Becker, S. & Davis, A. & Hall Giesinger, C. (2017) describes the five-year impact of innovative practices and technologies for primary and secondary education. The report highlights several key trends, significant challenges and developments in educational technology that have been elaborated to influence teaching, learning, and creative inquiry in K–12 education. Some of the key trends are relating more basically to technology and its impact on education, others relate to teaching practices, the role of teachers, evolving structures and processes in schools. It is interesting to note that these more global topics have gained awareness in the "NMC Horizon Reports" in recent years. Digital technology is no longer a topic that is confined to the discussion of some experts and some fore-front teachers interested in the use of technology for instructional reform. Digital technology has reached the mainstream discourse; it is acknowledged that schools are affected on an organizational level and it is not the individual teacher who will be able to redeem the potential of digital technology for innovations in teaching and learning. Learning lab’s approach of “digital school development” immediately can be assigned to the trends and challenges on the organizational level and how schools can adopt digitization as an organization. It directly links to "Rethinking How Schools Work" and "Rethinking the Roles of Educators" identified as key trends by Freeman et al. (2017).

Currently, schools are undergoing the process of transforming education in a digitized world. What this will be like is not determined solely by digital technology, but it is rather a question of design in which practices and regulations are negotiated in organizations and on a broader social level. These processes of transition offer many opportunities for innovation, present great challenges and uncertainties at the same time. Schools are confronted with the task of developing strategies to design teaching and learning environments for a digitized world,

considering the instructional potential of digital media and thereby continuing to fulfil their educational mission to enable students to participate in society and culture. In the past, initial attempts have been made to equip schools with digital technology and to train teachers accordingly. However, these efforts have been unsatisfactory because established structures and processes as well as traditional teaching and learning scenarios have not yet been successively adapted to the changed conditions as expected. A crucial element of German schools as a system is their stability, which is characterized by Prussian military tradition. Characteristics of this tradition are a strict hierarchical structure, discipline, order and traditions. Thus, a culture of openess towards something new as well as mistakes that can be seen rather as a chance than a failure and the principle of try-and-error are relatively uncommon in the German educational sector. In order to understand the transformative power of digital technology and the developmental options for schools, a research and development program has been initiated by regional school boards in 2016 where researchers from university cooperate with schools. The basic idea is to bring together schools within a geographical region to jointly discuss and develop their digital strategies under the support of the university's learning lab.

In the literature, various models exist to describe the change process of schools in the context of digital transformation. Some models relate to the fields of actions necessary to address the various challenges (Cabrol & Severin 2009). Other models describe the process of school development as a sequence of steps, like substitution, augmentation, modification to re-definition (Puentedura 2012). The TPCK-model (Angeli & Valanides 2009) explains competencies needed to be developed by teachers for integrating technology in classrooms: Besides the content knowledge (CK) on a given subject and pedagogical knowledge (P), a competent teacher will need technological knowledge (T) as well. The model describes the development of teaching

competences at the intersection of each element, e.g. how technology knowledge is necessary or contributing to content knowledge.

These theoretical models have been consulted as a backdrop for the "digital school networks" where schools collaboratively develop strategies and measures. The research question is how these models can be used as an input for the consultation for schools and how accurately these models describe the challenges and processes schools face in their endeavors to implement digital strategies. Decision-making in education policy and processes of change in organizations such as schools as well as the relationship between science and practice are far more complex. Specifically, the last argument will be examined in more detail in this chapter from a system-theoretical perspective.

How to…? Digital school networks in practice

As decribed above, research on education and educational practice are two communities that generate and use knowledge at different levels. They each follow a different logic in goals, interests, working methods and basic assumptions. This two-community-metaphor (Farley-Ripple, E. & May, H. &, Karpyn, A. & Tilley, K. McDonough, K. 2018) leads to the challenge of evidence-based change processes in school practice having to overcome the incongruence of communities. This is the task of the learning lab as a university partner of digital school networks. The practice community consists of school authorities as partners of the local political level, school principals of participating schools, stakeholders in state teacher training and committed teachers. As a scientific community learning lab establishes, accompanies and organizes the process of digitizing teaching and learning formats in schools with the aim of achieving a fruitful cooperation between the research and practice community. Learning lab's

thesis is that by bridging the gap these processes are successful through points of contact and overlaps between the two different communities, which can lead to an improvement in practice, based on empirically verified current research results.

How to…? Digital school networks in practice

The German educational landscape has a specific federal structure. The majority of schools is public, where the curriculum and structure are determined by 16 different federal state ministries. At municipal level the school authorities are responsible for the technical equipment. At all political levels, science and research are expected to provide evidence-based decision-making assistance on educational policies. Researchers are asked by both politicians and practitioners at schools to identify the measures that best fulfil the educational mandate in the digital world; teachers are expected to implement measures in order to have the desired effect (Farley-Ripple et al. 2018). In times of change and upheaval, this wish of the political actors is understandable but is too one-dimensional. The implicit basic assumptions behind it disclose why the process cannot have a successful outcome in this way. The process of decision-making on education policy programs is not solely determined by scientific expertise but is a complex phenomenon as political science differentiated since the 1960s (Easton 1965). Political institutions can be understood as systema to be in exchange with their environment. Demands of singular groups of citizens, associations or also political advisories constitute the input of the decision for political programs or laws in a complicated process. The overarching goal is to provide either change or the protection of societal conditions (Nullmeier, Wiesner 2003). The policy-cycle was developed on the basis of this system-theoretical model. Within the complex political decision-making-process it differentiates between six phases in order to facilitate the understanding (Windhoff-Heritier 1987) and to emphasize that the policy process does not end

with the implementation of policy-outputs. After all, there is no direct connection between the scientific and the practical community to implement current research results in practice.

Digital school networks as a program are sponsored by regional or community boards that are responsible for financing all school infrastructure (buildings, furniture, electricity, computer equipment, networks etc.) whereas teachers are paid by state authorities. With learning lab's support 70 schools in six networks have been working together for one to two years so far. Each network meets in different settings and committees in meetings, workshops and barcamps. Not every stakeholder is present in each event but only those who are affected by its outcome. Thus, topics concerning the level of organizational development are discussed with the principals, topics concerning pedagogical and didactical questions are discussed at meetings of the teachers and topics concerning the process' management are treated in the political leadership group. The learning lab coordinates and supports all events. This is how coherence and continuity are being provided for within the school network. These face-to-face meetings are crucially important for the collaboration of the stakeholders. This is the reason why school networks are geographically close and allow for short distances to meet.

The participating schools are public and are not competitors in their region. Therefore, collaboration in the networks does not interfere with a rivalling constellation of the schools in the networks. At the same time the learning lab tries to condense generalizable knowledge on how schools actively cope with the process of digital transformation. In this way, the learning lab founds, accompanies and supports the process of digitization of teaching and learning formats in schools with the aim of achieving a fruitful collaboration and bridging the gap between research

and practice community. This succeeds in points of contact and overlaps between the two levels leading to an improvement in practice based on empirically verified current research results.

From a system-theoretical perspective, theory and practice usually refer to interdependent, complementary elements of a change process in which the practice community can best identify the problems to be solved (Cohen L. & Manion, L. 2018). Therefore, the entry into cooperative networking is designed as a workshop, which is divided into three work phases and refers to a common vision of future schools. Presented by learning lab, the practice community identifies problems and challenges of working with digital media in general and additionally in an increasingly digitally shaped world of life and work. This phase is contrasted with a phase in which the negative aspects of the critical phase are turned into positive ones to imagine a utopian world. This can be achieved by the following steps: Participants imagine a world where there are no administrative, technical and organizational restrictions. What would such a world look like when integrating digital media? If the restrictions were not present anymore, where would be chances in their work? Within this phase, participants should be able to let go of the well-known doubts that often prevent good approaches from being developed.

Participants are empowered to develop a definition of goals that do not encounter the obstacles inherently in reality right at the beginning of the considerations. Subsequently, an overarching vision of learning, teaching and working with digital media at school is created. This work process is used to identify problematic areas and fields of action and to develop initial explanations and hypotheses, which form the basis for further joint work.

In this context, it is important to point out that learning lab has a specific understanding of the term ‘problem’. Problems (and conflicts) are not destructive per se. They contain a high

potential of energy, which has the quality to be the starting point of initiating the process of change. This is a highly sophisticated procedure, which requires professional organization of its processes. When discussing an identified problem, a dynamic process develops between stakeholders, which can be used constructively by a systematic, empathic and above all analytical support of dialogue. By risking disturbances and irritations of supposed certainties they can be called into question and thus be reflected upon. The process is worthwhile for developing innovative solution strategies. One example is the argument of many teachers and principals that first technical equipment needs to be available before approaching the topic of learning within a digitized world. When learning lab provocatively states that this is a welcome argument to not discuss a necessary change process, stakeholders are often irritated or defensive. After this direct exposure, it can be possible to discuss the apprehensions in the context of change. Examples may be the fear of excessive demands, that one's lack of knowledge might be exposed or the lack of time. Once these worries are taken seriously, the topic of digital education can be addressed on a new level. This part is carried out by the learning lab as research community. The scientific analysis of the dynamics and practices against the backdrop of theory can provide explanations for processes (McNiff 2010) and offer a deeper understanding of developments and conditions of the identified problems. In analyzing the problems learning lab considers the state-of-the-art research, which allows a different view of the problem areas through diverse perspectives.

Based on the reflexive processes, problem solving can be worked on. Collaborative thinking and working are central building blocks of working in learning lab's school networks. However, this does not mean that all actors work equally intensive on all aspects of problem solving but they rather develop measures and strategies in their respective specific thematic

areas. Learning lab understands this process as an organizational development process and identifies significant fields of action with the respective key stakeholders in order to structure the work in the network. In addition to technology and personnel development, which have already been mentioned above as fields of action, curriculum development and structures of organization have to be included in the change process in order to construct learning and teaching in the digital transformation era to be effective and professional.

This analytical work is followed by further joint work with the practice community. Before any steps are taken to overcome challenges, the implicit assumptions or hidden agendas such as attitudes, values, goals etc., which accompanied the identification of the problems, are made explicit by learning lab. It is possible with the help of a sound analysis on the basis of research findings that can be transferred into the practice community.

This offers the opportunity to modify the former critical area. In steering groups, school authorities and if applicable further involved training stakeholders agree on a basis of topics and dates for the individual elements of the network with learning lab. A focus is set on the persistent joint network meetings, which are often methodically conceives as a barcamp. The intensive dialogue that takes place across school borders is one of the possibilities for developing problem-solving strategies. In order to work on individual ideas in greater depth topic-related working groups are formed within network meetings.

After some schools and school authorities of a region have made the decision to understand the process of media integration as a lengthy and complex organizational development process in which the joint work in a school network under the leadership of the scientific expertise of the university is helpful, a so-called duty-stapler serves to reach a joint

agreement. The work in the network is long-term and serves the mutual, reliable support in the process. In this respect, it is important not only to perform tasks and appointments sporadically, but also to engage in joint work reliably and permanently.

Networking begins with the development of a common vision that focuses on the following questions: What can school life and learning in a digitized world look like? Which rules for handling of digital media should be followed? What should learning and teaching look like? These questions can be triggered by a media development process. Today's thought patterns and practices in schools can thereby be put to the test, are discussed a new and innovative ideas are developed that consider the advantages of using digital media such as more flexible learning arrangements or spatial independence. The potential of digital media develops only if technology is in the hand of learners and is possible for searches of educational resources of any medium like text, film, sound and picture or can be compiled collaboratively i.e. working on a subject in ePort.

An analysis of the common vision of the participants of the network makes it possible to identify fields of action which form the basis for further joint work.

A steering committee is responsible for planning implementation of the goals decided upon during the kick-off event in the different fields of action. In this process the school board with both actors of the federal state ministry and municipal politicians as well as principals of the schools and the learning lab are always involved. If necessary, other supporting stakeholder such as municipal media advisors, school authorities or actors in teacher training can also join the committee, which meets at least quarterly at the invitation of the school authority. The timing of the joined work, i.e. planned training measures, is coordinated in the school management group.

This committee, which in addition to the school authorities of the participating schools and the learning lab also includes the local school authorities and any other actors such as school media representatives discuss and coordinate administrative aspects of the integration of digital media. An important element are the network meetings, to which teachers and headmasters are equally invited. In the form of a barcamp, an intensive collegial exchange takes place on the topics that the teachers themselves bring in and shape. In this way, existing practical knowledge is used and topics that are currently relevant for schools are discussed.

Another format of the network meetings are further training courses on a specific topic, which can then be dealt with in greater depth. The learning lab is responsible for the organization and concept, whereby one of the central principles is to generate experts from the network itself. External partners only in exceptional cases support the exchange of best practices. At the beginning of the work in the network the competition between school administrations of the participating schools is still noticeable. At this point, the learning lab is called upon to build trust among schools, which is a central factor for working together in the network. This demonstrates the particular importance of the long-term process, which requires special support and moderation. The establishment of cooperative and collaborative forms of further education and work means nothing less than a paradigm shift.

At the beginning capacities and goals of the municipalities currently supported by learning lab are very different. The various networks differ depending on whether they are situated in an urban or rural area, the amount of schools in relation to the total number of schools in a municipality and how large the networks are overall. Learning lab currently supports school networks of five to 16 participating schools. To pay attention to this heterogeneity is central for a

successful work, so that the organization of the network is shaped differently by the learning lab with regard to the locations and access routes as well as the coordination processes. The respective commitment of the network partners and the possibility of involving supporting stakeholders is also different. This creates individual structures and work plans for each network, whose processes are adapted to the needs in regular meetings of the project partners.

An interesting point in this context is that the experiences that learning lab makes in the different settings can also be of advantage in other networks. Thus, different methods such as survey settings, concepts and practical knowledge for teaching and learning with digital media can be transferred. In that way, the networks benefit from each other, as learning lab brings together the different experiences.

However, it is not only the structures and organizations of the respective networks that are different. The content objectives may also differ, as they are determined, for example, by the existing technical equipment or the commitment and interest of teachers. Some networks work on basic technical equipment, while others tend to focus on the implementation of collaborative and cooperating forms of work.

In this context, the university partner has a decisive structuring task in the network, which distinguishes the form of committee work from everyday actions of school stakeholders. While operational thinking often prevails in practical work, in this process it is worthwhile and target-oriented to think more strategically. The school network offers the possibility to leave well-known modes of operation and to identify problems on a different level but also ways, developments and processes of change.

Promoting and fostering this form of thinking and working is an essential task of learning lab. Practices, the understanding of the processes and conditions in which the problem is situated, are discussed and reflected on the basis of content-related impulses from the research community.

Bridging the gap towards a common goal: learning in and for a digitized world

The principle of working in school networks is based on an approach that is often called action research in educational science. It aims at a deeper understanding of the complexity of teaching and learning against the backdrop of social change processes. The method is characterized by a democratic, collaborative approach, in which a free flow of information exists overcoming formal boundaries and often takes place in informal settings. What is important here is the ideal communication identified by Habermas (2011) in which the power of the better argument works. The fact that school as an organization is structured hierarchically, formally and bureaucratically, while the working principles of school networks run across it and are characterized by collegiality, collaboration and openness causes tension. The particular potential of cooperation lies within this interplay between schools and universities. If the way of working and thinking is reflected upon by the individual and new ground is broken by following other ways of working, it becomes more effective and professional. Kemnis (2009) describes this process as "[…] practice-changing practice […]" (p. 464). It is also a matter of encouraging a variety of approaches to interpretation, which should not lead to a uniform concept but rather to quite different, individual solutions for individual schools. In this way, a creative process of plurality can emerge.

In previous years, the relatedness between science and practice has often been the subject of scientific research to identify key success factors for their cooperation and clarify how current scientific research results can be given practical relevance (for a deeper understanding, Coburn & Penuel 2016). As a scientific partner, learning lab has been gathering practical experience in cooperation with school partners for several years. However, little attention has been paid to a crucial issue so far. It also proves to be a desideratum in the current research discussion: How are practice, science and evidence-based research results related to each other? It is particularly interesting to see how the research community generates knowledge and how it is used by the practice community. How do the two communities influence each other? And how do they influence educational policy decision-making?

Learning labs scientific approach focuses on design-oriented educational research. From this perspective, we see no value per se in digitization and mediatization of society but a potential to solve today's educational concerns and problems. The quality of innovative learning arrangements can only be measured by the concrete application of them. In this respect, practical application is of immanent importance for learning lab's scientific work, which does not take place through external observation but is based on the equal work of two different, complementary partners towards a common goal: developing innovative teaching and learning in and for a digitized world.

This project will only succeed if the gap between practice and research community can be bridged and they become a school-university-community in which various rationales of the individual partners have their justified place. The work of the learning lab in the digital school networks offers a suitable field of research to investigate the relationship of Luhmann's (1995)

subsystems in a scientifically founded way, due to the already existing relationship of trust between these actors.

The analytical framework by Farley-Ripple et al. (2018) is a suitable tool for an initial approach to the subject area. Along two dimensions it helps to identify structures, basic assumptions, perspectives and processes below the surface between the research and practice community, which shape the specific logic of thinking and acting of the respective community. One of the two dimensions identifies the depth with which processes are changed and traditional basic assumptions are recognized and reflected upon (Coburn 2003). The second dimension identifies the gap between communities along their outlook and attitudes towards research. Farley-Ripple et al. assume that depth is lesser the larger gap is. In other words, bridging the gap reaches intense depth for transforming learning and teaching.

Final Remarks

In our work on "digital school development", we are directly confronted with the problem how to combine the demands of the practical field with the agenda of the scientific world. Both fields do have research questions and, on first sight, these questions seem to be the same: How can we transform school and education into a digital world? How can we prepare teachers and students for education in a digital world? How can we use digital technology to enhance teaching and learning? What are the best digital tools and platforms for teaching and learning and how can these tools be introduced?

Teachers want to solve their developmental challenges in a given scenario. They need a solution that does fit to a certain and concrete situation and every school is different. Therefore, answers from one school cannot easily be transferred to other schools. In a traditional approach,

scholarly researchers would observe, document, categorize, systematize and analyze the answers schools have found for these challenges and therefore would systematically keep a distance as researchers. In a dialogical understanding of design-based research, researchers would actively participate in developing solutions with schools letting teachers gain from prior experiences with other schools and the expertise of documented experiences in the research literature. In the latter case, researchers must reflect on the dilemma that they are co-producers of "solutions" that have emerged in this process. Therefore, finding certain patterns of (digital) school development can be due to the mere fact that the "external experts" have proposed (or inflicted) a certain model that structures the process. Thus, the researcher is confronted with a "empirical reality" s/he has produced him-/herself.

There seems to be no essential way out of the dilemma of dialogical research approaches that have been discussed in qualitative research methodology extensively. However, there are several tools that can help to reduce the problems mentioned. In our research, documentation and reflection seem to be the most important and straight-forward elements contributing to solve the dilemma. (Possible) Findings should be documented (early) and should be presented as preliminary findings in the ongoing dialogue. A process of validating findings from one setting with other schools is also another step in the process of continuous development of improvement of theories and model based research which can yield as an input for other schools.

From our experience, this process of dialogical research in design projects needs further refinement. The aim should be to further the methodology of such approaches where researchers and practioneers in education actively construct designs and environments for learning.

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