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An inventory of technical didactic research in German-speaking countries

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1 Presentation by Daniel Pittich as JOTED co - editor

Prof. Dr. Daniel Pittich has been a “Juniorprofessor in the didactics of technology at professional colleges” at the University of Siegen since 2015. After an apprenticeship as a carpenter, he attended a vocational high school with a specialization in technology in Fulda to study at the Leibniz University Hannover to teach at vocational schools for woodwork and mathematics (2005-2010). In 2010, he took a position as a research associate at the TU Darmstadt in the field of technology didactics, where he graduated in 2013 researching the context of the quality of specialist knowledge and the competency of carpenters.

Prof. Pittich's scientific work focuses on professional and high school teaching and learning in technical domains. Current and former research and development focuses include competency models, competence acquisition, competence transfer and competency diagnostics at different levels and grades, production-technological learning factories, sustainability in vocational education, competence management in companies, curricular implementation processes and reform of Hessian vocational schools.

2 Overview and section of current discussions in the context of general and professional technical didactics

In the following section, an overview of the 13 contributions to this JOTED volume is provided. The contributions are based on selected lectures from the "1. Technological Didactics Symposium 2016" (24.11.2016 - 25.11.2016 at the TU Darmstadt). The central intention of the Symposium was to respectively build-up and expand scientific discussion as well as exchanges within the heterogeneous research area of technological didactics. Among other things, through the topics of MINT, technological change, skilled labor force and not least industry 4.0, it is foreseeable that this research and implementation area will gain in importance in the future and will probably grow. In addition to the disciplinary orientation points of occupational and economic pedagogy (Vocational Technology Didactics) and natural science disciplines or sciences (General Technology Didactics), numerous links to further scientific disciplines and their specific exploration of the subject of technology can be found in this context. Examples here are the sociology of technology, engineering philosophy and engineering history.

Through the symposium of the Technological Didactics Symposium 2016 and the contributions submitted to it, a first, albeit partial, survey of the various questions and interdisciplinary perspectives regarding technical teaching and learning could take place. In addition to the currently prominent topic areas "Problem Solving in Technical Domains" and "Digital Media in Technical Teaching and Learning", the aspects "Professional Action in Technical Teaching"

as well as questions concerning the relationship between "technology didactics and education" are developed and discussed.

2.1 Subject area "Problem Solving in Technical Domains"

The current prominent topic "Problem Solving in Technical Domains" in this JOTED issue by the contributions of Abele and Nickolaus (University of Stuttgart), Schray and Geißel (PH Ludwigsburg), Stemmann and Lang (University of Duisburg-Essen), Zinn and Hedrich (University of Stuttgart) and Breitschuh, Sonnenschein, Fuchs and Albers. Abele and Nickolaus work takes place - as in many previous studies - against the background of vocational training (automotive mechatronics). Zinn and Hedrich focus on the profession of the "service technician". Breitschuh et al. and Stemmann and Lang, on the other hand, tackle questions of problem solving at a high school level. Schray and Geißel sketch reflections and a study in the field of technology in the school sector (secondary level I). The studies of this topic "Problem Solving in Technical Domains" differed both in terms of their application contexts and implementation areas, as well as in their theoretical and research methodological approaches. As in the case of Abele and Nickolaus, the technical-didactic research area of problem solving in recent years has been dominated by quantitatively oriented approaches and empirical studies. These exploratory studies with large samples are often based on IRT and thus probabilistic analysis methods. The contributions of Stemmann and Lang respectively with their quantitative studies are also assigned here. Schray and Geißel, on the other hand, describe both qualitative and quantitative methods in an experimental control group design in their study to promote defect analysis. The study by Breitschuh et al. is designed as a (qualitative) comparison group design and is thus similar, but focuses on the (construct) validation of problem solving competence. Tin and Hedrich use surveys of service technicians (n = 47) to evaluate the learning environment LEX (Learn with an Expert). As in the contributions to this issue, the literature highlights two main points: 1) validation approaches of models, concepts and tools, or 2) studies of the effectiveness of treatments. The first group includes contributions by Abele and Nickolaus, Breitschuh et al, while the latter includes Stemmann and Lang, Zinn and Hedrich as well as Schray and Geißel. Despite the presentations and the consideration of a possible "clustering", it is hardly possible to compare or integrate the approaches or their findings. Similarly, this applies to the entire topic of "Technical Problem Solving" in the relevant literature. A variety of approaches have developed which can sometimes be juxtaposed and can only be related to each other. Within individual research groups, such as those around Nickolaus, it is possible to recognize the interdependent work

2.2 Subject area "Digital Media in Technical Teaching and Learning"

Compared to the topic of "Technical Problem Solving", the present work on "Digital Media in Technical Teaching and Learning" is sometimes more consistent. Although the studies differ in their theoretical background as well as the methodological approaches and procedures, they are similar in their thematic and content orientations. The main question is how technical learning can be supported, flanked or supported by digital media - consisting of software and hardware. The present articles by Stehling, Richert, Jeschke (RWTH Aachen) and Lach (TU

Darmstadt) form a broad spectrum of the possibilities associated with the use of digital media. While Lach analyzes a genuinely technical didactic teaching-learning medium on its use in technical learning and also partially develops teaching-learning scenarios, the study by Groß et al. goes beyond the immediate use of a medium. The latter have investigated ways of intensifying student collaboration through a virtual collaborative learning environment through a classical experimental and control group design. For this, Virtual Reality Head Mounted displays and laptop screens were used. These digital media have arrived in everyday life and also in the professional world, evident not least by the discussions in the context of the Megatrends "Industry 4.0". To what extent, however, complete cyber environments, as described by Gross et al. will be preserved in technical didactic learning-learning processes remains to be seen. It is worth pointing out at this juncture that current studies are being conducted and implemented to investigate the effectiveness of digital learning environments in the context of technical learning. In the current state of research, further studies are shown in this subject area - within technical didactics (relatively young) - which, similar to Lach, deal with the explicit didactic utility of digital media but also address questions of effectiveness.

2.3 Subject area "Professional Action in Technical Teaching"

A very traditional and at the same time current subject area in empirical teaching-learning research is that of "Professional Actions in (Technical) Education", whereby in the respective disputes of different domains the entire range of empirical approaches is observable. The three contributions to this JOTED volume can also be used as a (partial) document. The topics range from the perceptions and developments of specialist knowledge (Goreth, Rehm and Geißel, PH Ludwigsburg), to "Writing in Technology Teaching" (Schniederjan and Lang, University of Duisburg-Essen). This thematic breadth is also reflected in the research methodological approaches and designs:

In his study Dengler offers a material analysis and makes statements on various factors of metal-technical teaching in further qualitative approaches and then transfers these into initial quantifications. The approach of Goreth and Flagell uses valid video and text-based vignettes of qualitative expert surveys for validation and also, in later steps, quantitative questionnaire surveys. The study by Schniederjan and Lang is predominantly quantitative and analyzes the interrelations between literacy and competences among German and Turkish-speaking pupils. This short and excerpt-based account makes clear what kind of theoretical content and methodological diversity can be ascertained within the technical didactic (core) research area.

2.4 Subject area "Technology Didactics and Education"

The educational, didactic discourse of recent years is dominated by the work of competency orientation and empirical teaching-learning research. Work on more education-related facets of technology and technical teaching and learning in the tradition of Kerschensteiner, Grüner, Blankertz, but also Schelten, are only to be found separately in technical education. Such conflicts are often observable in technical sociology, technical ethics, but also in technical philosophy, and thus can be identified as a frame of reference that complements occupational pedagogy. As an example, the sociological contribution of Pfennings (DLR Stuttgart) can be

seen here, to which the author asks whether "technical didactics", as an area of a proper communication of technology-specific contents and topics, should not also deal with aspects of sociotechnology and the social meaning of different technical sciences. Within the scope of the symposium, a further topic complex of (technical) education could be taken up: studies with educational policy significance. Here the contribution of Adenstedt (University of Duisburg-Essen) and their empirical study on the technical self-concept of man can be found. Adenstedt argues that the technical self-concept is a major function in social participation, since technology, the handling of technical artefacts, but also a corresponding attitude towards technology, characterizes human behavior in (almost) all areas of life and also its phases. As further studies by Pfenning and Adenstedt suggest, the results of this work can be used to identify diverse approaches to different areas of technology-didactic research and practice and to implement them in specific studies.

3 An attempt to locate the interdisciplinary research area of "Technical Didactics"

At the beginning of this editorial, the background and ideas of the "1. Technological Didactics Symposium" were followed by a presentation of the contents and presentations in a summary of the individual contributions in the so-called topic areas.

In the lectures and contributions included in this JOTED edition, the thematic, theoretical and methodical spectrum of technological-didactic research became clear. Across the board it was found that in the course of future developments and a progressive technologization of our professional and working world, a growing importance will be given to "technical didactics". In addition to their relevance to content, the relevant structural developments appeared to be obvious: research structures have been set up at a number of university locations dealing with technical teaching and learning. It is interesting to see how these professors are structurally anchored in the discipline. Here, it is possible to identify positions in the fields of engineering, human and social sciences or even the humanities, which pose the general question of a disciplinary positioning of the interdisciplinary research area of "Technical Didactics". The combination of the various structural locations with the aspect of the overall spectrum of the thematic content of current work will determine that "Techical Didactics" is seen not as an independent discipline but as a hybrid research and development area with numerous interdisciplinary anchor points to different scientific disciplines. However, two recurring and thus also fundamental points of orientation can be identified: 1) the aspect of "technology" et al. with the reference disciplines of natural sciences, engineering sciences, engineering history, technical sociology, technical ethics, and technical philosophy, and 2) the aspect of "teaching and learning". With pedagogy (including general pedagogy, occupational & economic education and company & work education) as well as psychology (including pedagogical psychology as well as work and organizational psychology) as reference disciplines. It is already clear from this list that the research area has a variety of disciplinary anchor points, which are applied both to professional as well as general (technology) education. A glance at the literature in this respect confirms this (summarized in Tenberg 2011): For example, Schütte (2003) defines technical didactics, as argued above, as being about different disciplinary

paradigms. Bonz (2003) sees technical didactics as a summary of specialized technical disciplines and Bader (2001) argues that technical didactics is an area of mediation between general didactics and engineering sciences. Tenberg (2011) compiles these approaches and describes (professional) technical didactics on the one hand as an overlapping specialist didactics of vocational education and training (with a reference point to vocational education). Depending on the extent, this can correspond to both fields, but it may also partially act as substitutes for them. This assessment appears apt at least in the area of current professional technical didactics and targeted in connection with the treated contents, if not universally so. Because of the hybrid status, a professional-oriented technical approach (didactics) has recognizable strengths due to its direct application of technology, which in turn can also be made use of in general contexts of technology. On the one hand, the thesis is based on a broad and comprehensible research portfolio of the research groups involved so far, and on the other hand on the empirically supported implementations of the basic principles of technology in school practice.

The reasoning given here is - with the acknowledgement of corresponding restrictions - an inital attempt to characterize and render comprehensible a highly interdisciplinary research and development area. If one were to attempt to make an initial conclusion at this point, it would be necessary to establish that a technical didactics is moving into a scientific and social sciences theory and research space, that is based on education, science, and social sciences, assuming its contexts, models and instrumentarities, and in the professional field establishing comparable links with vocational education and training, such as the didactics of vocational education and training, but with much greater application (Tenberg 2011). This area of application ultimately results from engineering sciences as well as business subjects and fields of reference in mathematics, natural sciences, and technology, but also in technology-driven work itself. The scope of application is congruent with those of the individual disciplines and refers to school and/or company based learning and teaching.

The contributions and discussions of the "1. Technological Didactics Symposium "and this JOTED issue show that 1. the approaches to research and practice are sometimes inconsistent because of their concretization in individual domains and areas, but 2. these open questions concerning a fuzzy domain reference in the context of technological change can at the same time be understood as an opportunity with the potential for facilitating transferability.

4 Literature

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