"The main thing is practical work" – Teachers' beliefs supporting the intellectual development of technology education

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ABSTRACT

Although technology shapes our world comprehensively, technical education has hardly been discussed in Germany in the special context on mental development. Even though technical education is anchored in the curriculum, it is not yet known which beliefs teachers at special schools have about technical education. Teachers' beliefs play an important role in teachers' attitudes towards student thinking and how lesson content should be selected and taught. These beliefs were assessed in the present study via a qualitative research design involving teachers from special schools in Germany (N:9).

The results indicate that technical education is strongly practice-oriented and is mainly used to teach manual skills and work-related soft skills. The production task plays a special role here, as it proves to be a consistently important method in teachers' estimation. In the production process, teachers provide various forms of material and personal support. The aim is for pupils to achieve a successful and finished product and in the process experience themselves as successful. This production process requires a high degree of flexibility on the part of teachers regarding both the competence levels of the pupils and the technical requirements.

Important suggestions can be derived for the conceptual design of inclusive technical education, paying greater attention to pupils' individual needs. At the same time, however, the results point to a need for qualification, since teachers predominantly focus on only one specific area of technical competence. The goal of technical literacy intended for technical education programmes does not yet seem to be sufficiently achieved in the context on mental development.

Key Words: intellectual development, teacher beliefs, teaching practice, differentiation, assistive technologies

1. TECHNICAL EDUCATION IN THE SPECIAL CONTEXT OF MENTAL DEVELOPMENT

In order to promote emancipation and technological maturity, a general technical education is necessary for all pupils. The objective of general technical education is to enable pupils to deal responsibly and maturely with technology, including its design and evaluation. Maturity means being able to take responsibility in a world shaped by technology and to act appropriately, humanely, and in solidarity with others (Bienhaus, 2008, p. 6): striving for technological literacy enables an individual to engage with the many facets of the cultural field of technology (Stuber & Käser, 2019, p. 22).

In Germany, three approaches to technical education emerged in the 1970s: the general technological approach, the multi-perspective approach, and the work-oriented approach (Schmayl, 2019, pp. 124, 128, 133). In addition to addressing specific questions of method and content, which vary among the approaches, together they also shape the curricular anchoring of technical education in both independent and integrated subjects. In Berlin and Brandenburg, the federal states in which this study was conducted, technical education is linked with the integrated subject of business-work-technology and has historically developed around a work-oriented concept. In the work-oriented approach, the focus is less on technological reference points (e.g. design principles) and more on usability in the context of work (Zinn, 2018, p. 66). Workplace analyses, product analyses, and projects are core teaching methods and interdisciplinary teaching is favoured (Geißel, 2018, p. 219).

Despite educational efforts in the context of inclusion, the majority of pupils with intellectual disabilities in Germany are taught in special schools (Kultusministerkonferenz, 2022, p. XXII). However, due to the German educational system, the concepts followed to implement inclusion vary greatly from one federal state to the next, as does the rate of inclusion. Nevertheless, it can be stated for the special context of mental development in Germany that special schools are still an important place of education.

In the german school system the first exposure to technology-based content takes place in the general subject lessons (grade 1-4). From grade 5 (in the state of Brandenburg) or grade 7 (in the state of Berlin), pupils receive instruction in the subject of economics-work-technology studies (WAT). Here, the key competence "the pupils plan and manufacture products" (SenBildWiss Berlin & LISUM, 2011, p. 100) is identified for the special focus of mental development in the area of technical education, which is supplemented by the following subject areas:

- Materials and supplies
- Tools and technical equipment
- Product creation
- Hygiene measures and safety regulations (SenBildWiss Berlin & LISUM, 2011, p. 100)

Figure 1 Overview of the anchoring of technical education in the German school system for people with intellectual disabilities

grade	age	anchoring of technical education
12 [2] 11	17 16	Final level/ two-year prevocational training course "Berufsqualifizierender Lehrgang (BQL)"
10 [1] 9 8 7	15 14 13 12	subject economics-work-technology studies "Wirtschaft – Arbeit – Technik (WAT)"
6 5	11 10	
4 3 2 1	9 8 7 6	technology-based content included in the general subject lessons

Focus of this study: determine teacher beliefs' of compulsory technical education

[1] end of compulsory education
[2] end of compulsory vocational education

After the 10th year of school attendance, the pupils have completed their compulsory education. In order to fulfil their compulsory vocational schooling, two further school years follow, in which other curricular requirements come into play. Often these last years of schooling are completed at the same school, but sometimes also at a special vocational school. This school stage focuses on vocational orientation and preparation for life after school (Stöppler & Schuck, p. 2). In Berlin and Brandenburg, this stage is also referred to as the two-year prevocational training course "Berufsqualifizierender Lehrgang" (BQL) in the curricula (2013). Vocational qualifications are already taught here for a wide range of occupational fields. In the technical field, these include woodworking, ceramics, and metalworking.

2. IT'S THE TEACHERS WHO MATTER

Up to now, only a few studies have researched the intersection between technical education and inclusion. Even for the STEM subjects, which are widespread in the international context, there is also a great lack of research with regard to pupils with disabilities (Hwang & Taylor, 2016). In addition to studies on the effects of intervention programmes (Gottfried et al., 2016; Kolne & Lindsay, 2020; Theobald et al., 2019), barriers to access and participation in STEM programmes have also been identified (Dunn et al., 2012; Klimaitis & Mullen, 2021a). However, these studies do not specifically focus on technical education, nor do they explicitly refer to people with intellectual disabilities. Previous approaches to inclusive technical education in Germany are mostly of an older vintage (Duismann, 1992; Kuipers, 1984) and/or treat technical education from the perspective of the integrated subject of economics-work-technology studies (Duismann, 1981; Fischer & Pfriem, 2011; Mertes, 1984; Penning, 2023). Schaubrenner (2021) examines stress factors in inclusive teaching and their management via teacher training. Schaubrenner's theoretical-conceptual considerations on technical work in classroom workshops are of particular interest for this article (Schaubrenner, 2018a; 2018b). His results indicate that especially classes in workshops are particularly challenging for teachers and must be tailored to the individual needs of each pupil.

Although teachers at special schools teach technical education, little is known about their actual teaching practice and beliefs towards technical education. Particularly in the STEM subject, research has studied teachers' perceptions towards the subject in different countries and grade levels (Bell, 2015; Hsu et al., 2011; Park et al., 2017; Wang et al., 2020; 2011), as well as intervention measures to change teacher beliefs (Rich et al., 2017). In the field of technical education, teachers' beliefs about the use of robotics (Sullivan & Moriarty, 2009) and 3D printers have been studied (Cheng et al., 2020). There is no known survey of teachers' beliefs of the implementation of technical education in special schools, and therefore this is the focus of the current research project.

3. METHODOLOGY

The current research project investigates the following question: What beliefs do teachers at schools for intellectually and mentally disabled children have about technical education? A qualitative research approach was chosen to answer the research question.

3.1. Theoretical standpoint

Teachers' beliefs express what a teacher believes, what he or she trusts, what he or she subjectively considers to be correct and with which subject-related pedagogical ideas, views, world views and values - with which professional ideal - he or she identifies (Reusser & Pauli 2014, p. 644). Teacher beliefs integrate values held to be true and significant regarding pedagogical and subject educational responsibilities in teaching and learning processes, perceptions of role identities of learners and teachers, and assumptions regarding specific learning content and educational topics of their subject domain or overarching competency fields *(Reichhardt 2018, p. 76)*.Teacher beliefs can have a significant impact on teaching and student learning, as they guide a teacher's decisions and actions and are thus likely to yield insights into classroom practice. They have three main functions as (1) filters, (2) frames, and (3) guides for teachers' actions in the classroom (Fives & Buehl, 2012, p. 478).They can also become barriers to reforms (Kirchner, 2016, p. 114). Understood as an essential dimension of the professional competence of subject-specific teachers, they can be used to draw conclusions for teacher training and continuing education, as well as to identify common ground between school practice and subject didactics (Kirchner, 2016).

3.2. The sample

The sample of N:9 consists of teachers practicing in German special education schools in the federal states of Berlin and Brandenburg. In the sampling plan, a variance was aimed at with regard to the inclusion of both federal states, public and public schools, with regard to gender and the amount of professional experience in years.
During the research, it became clear that the structural division between WAT teaching in the compulsory education sector (grade 5-10) and at the vocational qualification level (grade 11-12, BQL) was hardly present in the sample. Thus, four BQL teachers responded to the interview call, even though it was specifically directed at WAT teachers. Two teachers taught both BQL and WAT. What is striking is that the majority of teachers surveyed only taught a sub-area of

WAT. Many of the teachers reported exclusively on their activity in the workshop, which relates to the processing of only one material. Most of them teach woodworking and some are also responsible for the maintenance of the classroom workshops. Occasionally, there were reports of other content areas of the WAT lessons or class leadership activities and lessons in other subjects. This might be explained by the interviewer's explicitly stated interest in technical education. However, since it is precisely this informal type of specialisation that is emphasised as a problem of compound subjects (Kirchner, 2023), it should be examined more closely in subsequent studies.

3.3. The data collection and analysis

A semi-structured interview according to Witzel & Reiter (2022) was developed. The interview guideline included open questions and narrative impulses and contained central didactic aspects such as competence orientation, didactic principles, choice of methods and media, among others (cf. table 1).

Table 1.
Excerpt from the interview guideline

What do you like most about teaching WAT?
Please tell me about a particularly successful WAT lesson
In your opinion, what are the special features of WAT lessons with pupils who have a special focus on mental development?
Which competences should your WAT lessons promote at best?
Which teaching methods do you think are particularly suitable for teaching WAT in the special focus of mental development?
Are there special didactic principles that are particularly important to you in your WAT lessons?

The interviews were subsequently transcribed and evaluated with the help of qualitative content analysis following Mayring (2022). Inductive category formation was used with the help of the Atlas.ti software.

4. TEACHER BELIEFS ABOUT TECHNICAL EDUCATION

4.1. Technical education is predominantly interpreted as leading to vocational qualification

The results make clear that the teachers place a particularly high value on practical craftmanship activities. They describe the special potential of practical crafting activities for the specific target group as a promising approach to learning as opposed to theoretically oriented teaching. They emphasise the great importance of "creating workpieces" for the pupils' sense of pride.

Through practical activities, pupils not only experience themselves as self-effective, but can also receive positive feedback from outsiders. Their achievements become visible through their workpieces. In addition, the practical approach is based on an orientation towards the future, which for the students primarily means working in a workshop for disabled adults. Such workshops are special systems of vocational rehabilitation and integration in Germany. In order to be well prepared for this, interdisciplinary learning goals such as perseverance, frustration tolerance, and independence are aimed at during instruction. Naturally, technical and manual skills are also emphasised. Interesting here is the emphasis on precise production and attention to detail, which is perceived in opposite ways by individual teachers: while for one teacher a high degree of dimensional accuracy is a central goal for vocational qualification, another teacher argues that the focus should be on promoting independence and self-efficacy.

Even if this strong vocational focus need only be the subject of teaching at the vocational qualification level, it also characterises the design of a WAT lesson, or cannot be distinguished from it. The main subject-related objectives are material and tool knowledge, specific production techniques including safety aspects, and independent planning of the work process. Teachers' beliefs' here vary regarding the scope of the planning steps. Some teachers involve the learners in the mental structuring of the entire production process "from the raw wood material to the finished object", for example, considering the procurement and cost of materials. Others focus on planning the day-to-day, concrete work steps. Here, the main focus is on enabling pupils to make an appropriate choice of materials and tools using the production techniques they have already learned. Finally, small-step processes also need to be planned, such as first measuring and marking the wood before drilling.

In the interviews, only non-digital production techniques are reported and, apart from the standing drill and scroll saw, mostly hand tools are used. Working on fast-running machines, such as a circular saw or band saw, is permitted by the accident insurance agency of the federal states of Berlin and Brandenburg from the age of 14, but is not mentioned by the teachers. Particularly with regard to the target group, special reference is made to the need to get used to noise when using machines. Some pupils find it difficult to tolerate the background noise. While some pupils have no sense of danger, others have a mild or intense fear of the machines, so their independent use by the pupils in itself is considered a success.

4.2. Designing differentiated teaching-learning processes

A variety of methods are used to tailor lessons to different students' needs, concentrated exclusively around the manufacturing task. When alternative methods are mentioned, their use is always closely linked to the manufacturing task, such as teaching the use of a stationary drill. The differentiated measures for production-related tasks range from dividing pupils into very small learning groups (rarely more than five pupils), restricting access to machines (besides the stationary drill, usually hand-held maschines), consciously selecting the tools and materials, and providing personal assistance. In particular, pupils' individual interests are taken into account in the selection and design of the products they will make.

The teachers explain that they build the object themselves during lesson preparation in order to analyse the manufacturing requirements in detail and plan their support for the pupils.

Particularly when the teachers base their products on real needs, for example, of the school community, they sometimes take over individual production steps themselves in order to ensure that the remaining steps fit their pupils’ performance level. The teachers state that a high degree of flexibility is required despite this extensive preparation. Only during the lesson does it become obvious where challenges lie.

During the production process itself, aids are used to compensate for the pupils' motor impairments or low level of competence in measuring and thus to increase the pupils' independence. In addition to personal support in the form of manual guidance, verbal instructions are given. Visualisations support the teaching process and partly also the production process. Learning from the teacher's model, which demonstrates the production steps, is very important, as is the repeated practice of production steps. These learning forms are not only characterised as a special feature of the acquisition of handicraft skills, similar to the learning of musical instruments, but are also emphasised as a specific feature of the student group.

Just as practise is described as ritualisation, other more structural elements of ritualised procedures are also recognisable. For example, entering the workspace is already seen as a ritual, which leads to a "switch in the mind" of the pupils, as a different form of discipline is required here with regard to work safety. Workflow planning is also used to begin the lesson in a ritualised way and get the pupils engaged in the lesson, and the goals of the next lesson are clarified at the end. This structuring takes places not only through a ritualised lesson plan, but also through visualisations. For example, work plans with photos or pictogrammes are used as prototypes, as well as for clarity.

5. DISCUSSION

According to the teacher beliefs examined in this study, hands-on activity in the context of mental development is a crucial element of technical education. This result is congruent with the "hands-on" orientation of STEM teachers, which Klimaitis and Mullen (2021b, p. 38) have highlighted not specifically for the intellecually disabled, but generally for "students with disabilities". In addition to involving the students, a perceived "increase in performance" was identified as the main reason for this orientation (Klimaitis & Mullen, 2021b, p. 38). The present study results also show that teachers emphasise practical learning as a successful learning strategy, which above all leads to visible and materialised successes of the students and thus promotes self-efficacy. All in all, the teachers interviewed value technical education for its post-school "usability" in everyday life, especially for work- and occupation-related activities. As a vocational perspective, the workshop for disabled adults is particularly emphasised by the teachers. This orientation reflects the theoretical approach behind a work-oriented technical education. The strong craftmanship orientation stands in direct contrast to the increasingly industrial and digitalised manufacturing processes in the work world today. This specific orientation could favour employment in the special system of workshops for disabled adult , although the dismantling of these very workshops is called for.

It is also debatable whether the work-oriented approach contributes sufficiently to pupils’ general technolgical maturity, as the multi-perspective approach to technical education would.

Especially in light of the currently heavily technologised world of life and work, a comprehensive technical education is necessary that not only enables individuals to use, produce, and communicate technology, but also to evaluate and dispose of it. In particular, further research on the technologically shaped living environment and its requirements for people with special needs would be desirable in order to contribute to their empowerment.

The work-oriented approach to technical education is also accompanied by a strong emphasis on manufacturing tasks. Other methods of technical education play a subordinate role in the teachers' beliefs. This result is compatible with the findings of Hsu et al. (2011), who found that primary school teachers considered it important to teach design, engineering, and technology, but were relatively unfamiliar with these fields. Teaching related to the production task does include some design elements. Hwang and Taylor (2016) also emphasise opportunities for self-expression for students with disabilities by expanding the concept of STEM courses to include elements of art lessons.

In accordance with the above-mentioned objectives of technical education, a sound subject-related didactic knowledge is necessary for all teachers. Teachers at special schools have comprehensive expertise in tailoring manufacturing tasks to learners' needs. However, they focus exclusively on this method, which mainly involves teaching manufacturing-related, manual skills and work flow planning, and does not cover all competence areas needed for a contemporary technical education. The very fact that almost all teachers in the sample had qualifications in subject didactics testifies to the low practical relevance of the learning content. The content should be oriented towards modern inclusive as well as subject-specific didactic concepts and research results.

The present results are based on a comparatively small sample surveyed in the federal states of Berlin and Brandenburg. A continuation of the research topic in the form of a dissertation written at the University of Potsdam is therefore planned. Furthermore, it would be desirable to initiate research on other topics of inclusive technical education which would contribute to closing the research gap and include the target groups of people with disabilities and all those active in the field.

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