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The Role of Teachers' Interest and Self-Efficacy in Implementing Technological Topics in Primary Education

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Abstract

The increasing societal pervasiveness of technology demands a solid foundation of technological literacy in primary education. In Germany, technological education is institutionally embedded within *Sachunterricht*, a multi-perspective subject unique to the German-speaking context (GDSU, 2013). Despite its curricular importance, empirical evidence indicates that technological topics remain significantly underrepresented in classroom practice, accounting for only 10.5% of instructional time (Möller et al., 1996; Steffensky et al., 2024). While structural explanations have been discussed (Möller et al., 1996), teacher-related dispositions – specifically individual interest and self-efficacy beliefs – require a systematic re-examination under contemporary conditions.

Building on the TeBiS study (Möller et al., 1996), this paper reports results from the third pilot phase of an extended replication (N=16) with pre-service teachers during their practical semester. The study differentiates rigorously between individual interest (Krapp, 1992), self-efficacy beliefs (Bandura, 1997), and implementation behaviour. Results indicate a slightly below-average individual interest (M= 2.39) and moderately pronounced but highly heterogeneous self-efficacy expectations (M= 2.69). Correlational analyses reveal a non-significant negative relationship between interest and implementation (r= – 0.33) and a weak positive relationship for self-efficacy (r= 0.16). Contrary to linear assumptions, the pilot data suggest that individual dispositions alone do not sufficiently explain implementation behaviour. These findings underline the necessity of modelling implementation as a multi-level phenomenon that integrates macro- (policy), meso- (school context), and micro-level (teacher) factors. Due to the small sample size, conclusions remain exploratory and primarily serve instrument refinement for the main study in 2026.

Key Words: Technology Education in Primary School, Sachunterricht, Teacher's Interest, Teacher's Self-Efficacy, Implementation

1 INTRODUCTION

Technology exerts a profound impact on contemporary society and has become an integral part of almost all areas of life (Ropohl, 2009). For children, this manifests through both digital media (Gervé, 2016) and the ubiquitous use of technological devices in their everyday environment (Möller & Wyssen, 2018). Consequently, technological education – defined here as the development of basic technological literacy – is essential for enabling primary school children to navigate and act competently within an increasingly complex world (Landwehr et al., 2021).

Importantly, this contribution does not equate 'technology' with digital media alone. In line with the system theory of technology (Ropohl, 2009), technological content refers to human-designed artefacts, processes, and systems – including but not limited to digital technologies. This terminological clarification responds to international concerns regarding the conflation of technological education with digital education.

Building on the premise, the primary school stage is critical for establishing a foundation for technology-related dispositions. However, the extent to which technological content is integrated into the classroom remains a subject of concern. To contextualise this for an international audience, it is necessary to examine the specificities of the German education system.

1.1 Contextualising Technological Education within the German 'Sachunterricht'

The education system in Germany is structured into several successive stages, defined by a clear distinction between early childhood services and formal schooling. Contrary to international systems where formal education often begins earlier, the German model separates the 'elementary sector' from the primary stage. The elementary sector encompasses non-compulsory early childhood education in day nurseries for children aged zero to six. While providing foundational stimulation, it remains distinct from the compulsory school system, which commences with 'primary education' (KMK, 2023).

Building on this organisational premise, primary school constitutes the first stage of formal school education. It is typically attended by children aged six to ten and, in most federal states, comprises grades one to four (with the exception of Berlin and Brandenburg, where it extends to grade six). Crucially for the international reader, technological education is not institutionalised as a standalone subject within this framework. Instead, it is integrated into *Sachunterricht* (GDSU, 2013). During their university-based teacher training (primary teacher training), pre-service teachers receive instruction in all perspectives of this integrated subject, although the depth of technological training varies significantly between federal states and institutions.

Contrary to traditional mono-disciplinary assumptions in technological education, *Sachunterricht* follows a 'multi-perspective approach' (GDSU, 2013). It integrates historical, geographical, scientific, social, and technological perspectives. The technological

perspective aims to empower primary school pupils to navigate a technology-driven society, for example, by utilising tools, machines, and devices to solve technological problems.

However, the inherent 'multi-perspectivity' of the subject often leads to a marginalisation of the technological component in favour of more established scientific or social perspectives (Steffensky et al., 2024). The following section examines the role of teachers in *Sachunterricht*, focusing on the factors that influence the behaviours and conditions affecting the implementation of technological content.

2 THEORETICAL FRAMEWORK: COGNITIVE AND MOTIVATIONAL DETERMINANTS OF TECHNOLOGICAL EDUCATION

Contrary to traditional, mono-causal assumptions that curricular prescriptions directly dictate classroom practice, contemporary educational research conceptualises implementation as a complex, non-linear process mediated by systemic layers. Drawing on the foundational TeBiS study (Möller et al., 1996), we utilise a heuristic multi-level model to categorise the factors influencing the enactment of technological literacy in primary education.

Table 1

A heuristic multi-level model with key factors and determinants that influence the enactment of technological literacy in primary education

Level	Key Factors & Determinants
Macro Level	Encompasses socio-political frameworks and curricula, e.g. the Curriculum for primary schools in North Rhine-Westphalia (MSB, 2021)
Meso Level	Includes school-specific context characteristics, such as the availability of material resources (e.g., construction kits, digital labs), leadership support, and institutionalised professional development.
Micro Level	Focuses on teacher-related factors which, building on the premise that the teacher is the ultimate gatekeeper of the curriculum, represent the most critical nexus for instructional change.

2.1. Self-efficacy

The effective implementation of technology education in primary schools is fundamentally underpinned by a complex interplay of cognitive and motivational factors. Within this micro-level architecture, self-efficacy constitutes a pivotal cognitive mediator between pedagogical knowledge and actual classroom performance. Defined as the belief in one's capability

to organise and execute the actions required to achieve specific goals (Bandura, 1997), self-efficacy is considered a key characteristic of professional teaching (Mietzel, 2017). It significantly influences cognitive, motivational, emotional, and behavioural processes, ultimately determining how challenges are tackled (Schwarzer & Jerusalem, 2002).

In the specific domain of primary technology education – where many teachers may feel 'technologically under-prepared' – high self-efficacy could act as a catalyst for innovation. Teachers with robust beliefs in their technological competence are not only more likely to adopt ambitious, technology-oriented teaching approaches but also tend to demonstrate greater resilience when facing the inherent unpredictability of hands-on technological topics. Furthermore, educators with high self-efficacy often set more ambitious goals, invest more time in preparation, and systematically use learner feedback to refine their practice (Ditton & Arnoldt, 2004).

As Schneider and Tenberge (2025) have indicated, empirical research into the specific relationship between self-efficacy beliefs and technological education remains limited. However, theoretical frameworks suggest that self-efficacy expectations might play a central role in the implementation of technological content, as teachers act not only in accordance with curricular requirements but also based on their internal expectations of their own abilities (Schwarzer & Jerusalem, 2002; Mietzel, 2017).

2.2. Individual Interest

In addition to self-efficacy, educational research identifies individual interest in technological topics and their pedagogical application as another key motivational factor that could significantly influence teaching behaviour and lesson design. From a theoretical perspective, interest is defined as a relatively stable person-object relationship (Krapp, 1992). In this context, the 'object' refers to specific technological content or topics that elicit a greater willingness to engage in depth.

While foundational research has primarily focused on primary school students (learners), showing that interest significantly dictates the intensity and quality of learning (Schiefele, 2009), there are few empirical approaches that extend these findings to educators. Nevertheless, extending this framework to teachers suggests that their individual interests could significantly influence lesson design (Straube et al., 2020). It is essential to differentiate between two types of interest:

- Situational Interest: A transient state triggered by specific external stimuli, such as a particular digital tool or a creative teaching sequence.
- Individual Interest: A long-term, stable motivational disposition characterised by high emotional and value-related valence toward a subject area.

In the field of technological education, conclusions can be drawn from related research in *Sachunterricht* (Straube et al., 2020). As a constant personality trait, individual interest influences long-term engagement and knowledge acquisition (Schiefele, 2009). Especially

in *Sachunterricht*, where teachers exercise high autonomy in topic selection, individual interest serves as a primary filter for curricular enactment. Teachers with a high personal affinity for technological topics are more likely to invest the effort required for complex technological units and seek subject-specific further training. Consequently, teachers' individual interests could emerge as a decisive factor in the implementation of technological topics in primary education.

3 PROBLEM OUTLINE: THE PERSISTENCE OF THE 'IMPLEMENTATION GAP'

The increasing societal pervasiveness of technology demands a foundation of technological literacy in primary education. Beyond functional usage, teaching technological content is a prerequisite for fostering 21st-century skills – specifically critical thinking, complex problem-solving, and creativity (SWK, 2021). In Germany, this educational mandate is institutionally embedded within *Sachunterricht*. However, a significant discrepancy exists between the curricular status of technology and its actual enactment in the classroom (Beutin et al., 2023). The TeBiS study (Möller et al., 1996) remains a seminal reference point, demonstrating that the implementation of technological topics depends on numerous factors. Crucially, Möller et al. (1996) revealed that less than half of the surveyed teachers (N= 535) integrated technology into their lessons, with only 25% feeling competent to do so.

Contrary to the assumption that the technological acceleration of the last three decades would instinctively lead to an increase in formal technological education, empirical data suggest a remarkable systemic stagnation. While the 'depth and immersiveness' of technology in everyday life have escalated since 1996, the school-based response remains fragmented. Current findings from the Trends in International Mathematics and Science Study (TIMSS, 2023) confirm this 'persistence of marginalisation': technological content accounts for a mere 10.5% of instructional time, lagging significantly behind the scientific and geographical perspectives (Steffensky et al., 2024). This is further corroborated by recent analyses of national framework plans, where the technological perspective is represented at only 9.8% (Beutin et al., 2023).

Building on the theoretical premises of Bandura (1997) and Krapp (1992), it becomes evident that the mere presence of technology in a child's environment does not translate into high-quality instruction. Instead, the teacher acts as the ultimate gatekeeper. Although the influence of individual interest and self-efficacy on general lesson design is well-documented in psychology, their specific impact on the enactment of the 'technological perspective' in *Sachunterricht* remains empirically under-researched under contemporary conditions. This study seeks to address this lacuna by re-examining these professional dispositions in the light of current curricular demands (e.g. *Curriculum for primary schools in North Rhine-Westphalia* (MSB, 2021)).

4 RESEARCH QUESTIONS

Building on the systemic framework, this study aims to identify and analyse specific teacher-related factors that act as predictors for the classroom enactment of technological topics in the

primary sector. This research prioritizes the internal dispositional landscape of educators, as these micro-level factors often act as the final gatekeepers of curricular innovation. To achieve this, the study focuses on the following research questions:

(i) To what extent do pre-service teachers demonstrate an individual interest in technological topics?
(ii) How pronounced are their self-efficacy expectations regarding technology-oriented instruction?
(iii) How do these dispositions correlate with the actual implementation of technological content?

5 RESEARCH DESIGN AND METHODOLOGY

To provide an empirical basis for investigating the identified research questions, this study employs a quantitative design, framed as an extended replication of the TeBiS study. Contrary to the original 1996 design, the current questionnaire has been modernised to reflect contemporary standards of technological literacy and psychometric validation.

Building on the premise that an understanding of technology education requires a cross-sectional perspective on professionalisation, the research design expands the original scope of the sample. Specifically, the study is strategically structured to include both pre-service teachers (university students in their practical phase) and in-service teachers (practising professionals in primary schools). This expanded sampling strategy is designed to identify longitudinal shifts in individual interest and self-efficacy, thereby allowing for a more robust analysis of how professional experience moderates the implementation of technological content in *Sachunterricht*. By integrating these cohorts, the study moves beyond snapshot of teacher training.

5.1. Instrumentation and Operationalisation of Teacher Dispositions

The survey was conducted via a multidimensional questionnaire, which was refined through three consecutive pilot phases to ensure structural validity. Building on the premise that teacher dispositions are multi-faceted, we employed differentiated scales to capture individual interest and self-efficacy with high psychometric precision.

Individual Interest: This construct was operationalised using eight items based on the Interest Scale by Rakoczy et al. (2005). This scale assesses the stable, person – object relationship with technological topics on a four-point Likert scale (1 = strongly disagree to 4 = strongly agree). The decision to utilise a forced-choice format without a neutral midpoint was strategically made to minimise central tendency bias and ensure the emergence of clear dispositional profiles.

Self-Efficacy Expectations: This dimension was measured through 24 items across six subscales, adapted from Holtkemper (2022). These subscales represent the specific demands of technology-

oriented instruction, encompassing facets such as the design of technological solutions and the evaluation of technological impacts.

Implementation Frequency: This was captured through a self-reporting mechanism where respondents indicated whether they had already conducted or planned specific technological units during their professional practical training.

5.2. Sample Characteristics and Contextual Embedding

The present contribution reports on the third pilot phase, involving a cohort of N=16 pre-service teachers enrolled at Paderborn University. These participants were recruited during their mandatory practical semester, a pivotal stage in the North Rhine-Westphalian (Germany) teacher training programme. During this six-month period, students are actively engaged in teaching *Sachunterricht* in primary schools (Grades 1–4), providing a specific nexus between academic theory and classroom enactment.

This cohort was selected to evaluate the refined instrumentation within the context of early career professionalisation. Whilst the sample size reflects the exploratory nature of this pilot stage, it allows for a focused analysis of how initial teaching experiences interact with dispositional factors such as interest and self-efficacy. The data collected from this group serves to establish a baseline for the subsequent, large-scale investigation involving a broader range of both pre-service and in-service professionals.

To ensure high linguistic quality and clarity for an international audience, generative AI tools, specifically DeepL and DeepL Write, were utilized for the translation and stylistic refinement of this manuscript

6 RESULTS AND DISCUSSION

This article focuses on the results of the third pilot study; findings from previous cycles are not reiterated here (Schneider & Tenberge, 2025). While the quantitative results do not reach statistical significance, they provide important exploratory insights and raise critical questions regarding prevailing assumptions in the field. The quantitative analysis provides a insight into the dispositional profiles of pre-service teachers and their instructional engagement.

6.1 Descriptive Status of Teacher Dispositions

To assess individual interest, eight items were aggregated into a scale. As the instrument employed a four-point, positively worded Likert scale without a neutral point, the theoretical midpoint (2.5) serves as the conceptual boundary for interpretation. Mean values below this threshold indicate lower levels of interest, whilst values above signify higher interest. Analysis yielded a mean score of M=2.39 (SD=0.81), situated below the theoretical centre. This suggests that the sample generally demonstrated a low, albeit only marginally below-average, interest in technological topics. A look at the distribution reveals that eight students scored below the midpoint and seven above (with one exactly at the centre), reflecting heterogeneity.

Following the conceptualisation of interest as a stable person–object relationship by Krapp, this heterogeneity suggests that pre-service teachers differ in their prior experiences and motivational orientations towards technological content. In the context of *Sachunterricht*, this is particularly relevant, as the subject's multi-perspective structure allows for considerable autonomy in content selection, thereby amplifying the potential impact of individual dispositions.

6.2 Relation Analysis: The Interest, Self-Efficacy, and Implementation Nexus

To explore the relationship between teacher dispositions and classroom practice, a point-biserial correlation analysis was conducted. This method was selected due to the dichotomous nature of the implementation variable (implemented vs. not implemented).

Table 2

Point-biserial Correlations between Teacher Dispositions and Technology Implementation (N=16)

Variable	Correlation (r)	Effect Size (Cohen's d)	Significance (p)
Individual Interest – Implementation	-0.33	Medium	.21
Self-Efficacy – Implementation	+0.16	Weak	>.05

Whilst these results do not reach statistical significance due to the pilot nature of the sample (N=16), several tendencies are noteworthy. The weak positive relationship between self-efficacy and implementation is broadly consistent with the theoretical framework of Albert Bandura, which posits self-efficacy as a determinant of action. However, the limited strength of this relationship indicates that self-efficacy alone is insufficient to account for observable teaching practices.

Most notably, the negative association between individual interest and implementation contradicts dominant assumptions in educational research. It suggests that, in this dataset, the implementation of technological content was associated with lower rather than higher levels of interest. Rather than interpreting this finding as an anomaly, it may be understood as an indicator of the specific conditions of early professionalisation.

During the practical semester, pre-service teachers operate within a constrained instructional environment shaped by curricular requirements, mentor expectations, and institutional routines. Consequently, instructional decisions may be less driven by personal motivational dispositions and more strongly influenced by external factors. In this sense, the findings point to a potential 'suppression effect', whereby contextual conditions temporarily override individual interest. This

interpretation aligns with a multi-level understanding of implementation, in which micro-level dispositions interact with meso- and macro-level structures.

6.3 Synthesis of the Pilot Findings

In summary, the pilot data reveals a 'dispositional disconnect'. Pre-service teachers demonstrate a foundational level of self-efficacy, yet this does not consistently translate into the implementation of technological content, particularly in the presence of comparatively low or heterogeneous individual interest. The findings suggest that the relationship between teacher dispositions and instructional practice is neither linear nor straightforward. At the same time, these results must be interpreted with caution. The small sample size (N = 16) restricts the statistical power of the analysis and limits the generalisability of the findings. The reliance on self-reported data captures perceived rather than observed behaviour. Nevertheless, the pilot study serves an important function in refining the research design and generating hypotheses for further investigation. The expansion of the 2026 main study, including pre-service and in-service teachers, will allow for a more robust examination of whether the observed patterns persist as teachers gain professional autonomy. In this way, the present findings provide a necessary empirical and conceptual foundation for addressing the broader challenge of the persistent 'implementation gap' in primary technology education.

7 CONCLUSION AND OUTLOOK

The pervasive nature of technology in the 21st century necessitates a fundamental re-evaluation of its role within primary education. This pilot study, framed as an extended replication of the TeBiS study, contributes to the current discourse by identifying factors influencing the implementation of technological topics within *Sachunterricht*. Building on the empirical evidence presented, several key conclusions can be drawn of technology education:

The negative correlation ($r = -0.33$) between individual interest and classroom enactment suggests that in the early stages of professionalisation, personal motivational dispositions are often suppressed by external systemic factors. Contrary to the assumption that personal interest is the primary driver of innovation, the practical semester appears to be a phase where institutional mandates and mentor guidance exert a dominant influence. Whilst the sample size of the third pilot phase (N=16) precludes broad statistical generalisations, initial indicators have been identified regarding the relationship between teacher dispositions and the implementation of technological content. The findings confirm that the mere presence of technology in a child's environment does not instinctively translate into high-quality instruction; the teacher remains the ultimate gatekeeper.

The inclusion of in-service teachers will allow for a analysis of how professional experience moderates the relationship between dispositions and practice. Future research will systematically record school-specific resources to evaluate how the availability of material tools interacts with teacher self-efficacy. In conclusion, fostering technological literacy in primary education remains a multifaceted challenge. This study provides the necessary empirical baseline to refine

professionalisation strategies, ensuring that the technological perspective in Sachunterricht moves from the periphery to the centre.

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