A transdisciplinary evaluation framework for the assessment of integration in boundary-crossing collaborations in teacher education

Straub, Robin; Kulin, Sabrina; Ehmke, Timo

Published in:
Studies in Educational Evaluation

DOI:
10.1016/j.stueduc.2020.100952

Publication date:
2021

Document Version
Publisher's PDF, also known as Version of record

Studies in Educational Evaluation 68 (2021) 100952

Contents lists available at ScienceDirect

Studies in Educational Evaluation

journal homepage: www.elsevier.com/locate/stueduc

A transdisciplinary evaluation framework for the assessment of integration in boundary-crossing collaborations in teacher education

Robin Straub [a,*], Sabrina Kulin [a,b], Timo Ehmke [a,c]

[a] Zukunftszentrum Lehrerbildung, Leuphana University of Lüneburg, Universitätsallee 1, 21335, Lüneburg, Germany
[b] Faculty of Educational Science, University of Hamburg, Von-Melle-Park 8, 20146, Hamburg, Germany
[c] Institute of Educational Science, Leuphana University of Lüneburg, Universitätsallee 1, 21335, Lüneburg, Germany

ARTICLE INFO

Keywords:
Teacher education
Researcher practitioner partnerships
University-school partnership
Boundary-crossing
Collaboration
Transdisciplinarity

ABSTRACT

This study provides a) an evaluative framework for boundary-crossing collaboration in teacher education which is inspired by the discourse of transdisciplinarity. In addition, it offers b) empirical insights about so-called Transdisciplinary Development Teams, which comprise practitioners, researchers, and student teachers. The framework bases on (1) epistemic, (2) social, and (3) organisational integration characteristics such as (1a) *mutual learning*, (1b) *knowledge integration*, (2a) *perceived trustworthiness*, (2b) *appreciation within the team,* and (3a) *collective ownership of goals*. Drawing on a written survey with $n = 62$ participants, the empirical study provides findings on three research questions. First, all dimensions of integration characteristics have been rated high on average. Second, the results of a one-way ANOVA establish that the main actor groups perceive the work in Transdisciplinary Development Teams as integrative with regard to previously stated characteristics. Third, the analysis of a manifest path model substantiates theoretically assumed effect relationships. Subsequently, transdisciplinary dimensions of integration characteristics appear suitable for assessing boundary-crossing collaboration in teacher education.

1. Introduction

The advancement of teacher education has been outlined recurrently as a boundary-crossing challenge calling for collaborative formats among stakeholders from various institutions and professional backgrounds, for instance, practitioners, researchers, and student teachers (Straub & Vilsmaier, 2020; Hartmann & Decristan, 2018; Lillejord & Børte, 2016). Advantages of such collaborations are seen in their potentials for a) the development and implementation of didactical innovations (Gräsel, 2011), b) professional development of (prospective) teachers and teacher educators (Postholm, 2016) as well as c) collective capacity building and institutional change (Fullan, 2016). Thus, boundary-crossing collaborations have to be understood as a crucial factor to promote effectiveness and innovative capabilities in teacher education systems.

These considerations are of particular importance with regard to the German context. Due to its loosely-coupled, consecutive, and three-phased model (Kotthoff, 2011), the German teacher education system counts as highly specialised but also institutionally fragmented by international comparison (Blömeke, 2014; European Commission/EACEA/Eurydice, 2015). The first phase at universities aims, in contrast to other European countries, at the concurrent acquisition of subject-related content knowledge as well as knowledge in pedagogies, learning psychology, and educational sciences. The second phase comprises the preparatory service at teacher education institutes (German: 'Studienseminare') and schools. It focuses on practical education in genuine classroom settings. The third phase refers to advanced professional development during the teaching career. Therefore, boundary-crossing coordination and collaboration at the organisational, personal, and curricular level are key factors in pursuit of further integration and coherence (Hellmann, 2018; Hericks, 2004).

Against this background, an increasing number of collaborative formats have been established at various institutional intersections between university-based teacher education and school practice (Kleemann, Jennek, & Vock, 2019; Villiger & Trautwein, 2015). Such collaborations are located predominantly within the context of practical seminars and school placements (Pilypaitytė & Siller, 2018) as well as school development and evaluation projects (Alpert & Bechar, 2007).

However, despite of this vibrant discourse and the increasing amount of studies, further conceptual propositions and empirical insights are

* Corresponding author.
E-mail address: robin.straub@leuphana.de (R. Straub).

https://doi.org/10.1016/j.stueduc.2020.100952
Received 6 April 2020; Received in revised form 13 October 2020; Accepted 17 November 2020
Available online 13 December 2020

needed to substantiate the integrative potentials and to unravel underlying effect mechanisms of boundary-crossing collaborations. The present article addresses this research gap by proposing a) an evaluative framework inspired by the discourse of transdisciplinarity and b) by offering empirical insights about a boundary-crossing collaborative format termed Transdisciplinary Development Teams (TDTs).

2. Theoretical background and research context

2.1. Introducing transdisciplinarity

Transdisciplinarity stands for an integrative mode of research and development which highlights the interactive interrelation of various sources of expertise across professional and institutional boundaries in order to co-construct solutions for both, the academic and the practical field (Hirsch Hadorn et al., 2008; Klein, 2014; Scholz & Steiner, 2015).[1] This allows for generating 'socially robust knowledge' and hands-on solutions for complex challenges in everyday practice. The term 'socially robust knowledge' was introduced by Nowotny, Scott, and Gibbons (2001, p. 166) and refers to the assumption that transdisciplinary processes promote the integration of scholarly bodies of knowledge as well as practical expertise. This is supposed to have beneficial effects on the 'legitimacy, ownership, and accountability' (Lang et al., 2012, p. 26) of innovative approaches at professional and organizational boundaries. In this way, transdisciplinary processes address both, scientific credibility and practical relevance (Lang et al., 2012; Vilsmaier et al., 2015).

In accordance with that, integration has to be understood as a paramount requirement for transdisciplinary collaboration. However, due to the fact that transdisciplinarity addresses research and development processes across professional and institutional boundaries, Jahn, Bergmann, and Keil (2012) and Lang et al. (2012) advocate for a multi-dimensional understanding of integration. In that respect, an adapted version of the original framework will be proposed in this article that focuses on (1) epistemic, (2) social, and (3) organisational requirements for boundary-crossing collaboration.

2.2. Dimensions of integration: epistemic, social, and organisational

The following sections provide a compact outline on (1) epistemic, (2) social, and (3) organisational dimensions of integration and introduce selected constructs for measurement accordingly. Epistemic integration, for instance, refers to (1a) *mutual learning* and (1b) *knowledge integration*. Social integration is reflected in terms of (2a) *perceived trustworthiness* and (2b) *appreciation within the team*. Finally, organisational integration refers to (3a) *collective ownership of goals*.

2.2.1. Epistemic integration: mutual learning and knowledge integration

The epistemic core of transdisciplinarity is commonly understood as processes of *mutual learning* and *knowledge integration* (Jahn et al., 2012; Scholz & Steiner, 2015; Vilsmaier et al., 2015). However, as the following definitions indicate, both characteristics are used in a broad sense and rather interchangeably so far. *Mutual learning* is understood as a 'basic process of exchange, generation, and integration of existing or newly developing knowledge' (Scholz, 2001, p. 118) and 'allow for combining scientific insights with knowledge gained in non-scientific contexts' (Vilsmaier et al., 2015, p. 564). Therefore, mutual learning has to be understood as a co-constructive process which expresses itself, for instance, in terms of joint development of teaching concepts and materials (van Schaik, Volman, Admiraal, & Schenke, 2019). In addition, *knowledge integration* is characterised by the exchange of information and knowledge in order to develop a shared understanding and common knowledge base about joint research and development issues, working styles, and methodologies as well as goals and outcomes (Godemann, 2008).

In order to operationalise these characteristics more differentially, we argue that *mutual learning* is a behavioural capacity that supports *knowledge integration.* In alignment with that, *mutual learning* comprises aspects of exchange and co-construction among actors from different backgrounds, while *knowledge integration* highlights the establishment of shared understandings and common ground for joint research and development processes.

2.2.2. Social integration: perceived trustworthiness and appreciation within the team

In alignment with the concept of dimensions of integration, epistemic processes that base on interactive exchange and co-elaboration of new knowledge objects, are embedded in social and organisational relations. Especially in team-based research and development settings, trust-based and appreciative relationships have been outlined as powerful influencing factors (Hedges, 2010; Sewell, Cody, Weir, & Hansen, 2018).

Perceived trustworthiness refers to the positive expectation towards the benevolent behaviour of others, which then allow engaging in interactions under conditions of uncertainty (Luhmann, 2017). In accordance with this, various contributions highlight the constituting role of trusting relationships in professional pedagogical settings (Bartmann, Pfaff, & Welter, 2012), in school-university partnerships (Sewell et al., 2018), and in educational innovation networks (Kolleck & Bormann, 2014). Moreover, especially in transdisciplinary settings, *appreciation within the team* in terms of 'accepting the otherness of the other' (Scholz & Steiner, 2015, p. 532) and the 'recognition of difference' (Hedges, 2010, p. 309) are understood as a constituting characteristic in order to establish reliable working relationships (Kulin, 2019).

The appreciation of contributions from actors with diverse backgrounds is considered essential for co-constructive processes. Esteeming behaviour articulates itself in openness towards different opinions and by feeling safe and encouraged to engage also in controversial debates (Carmeli & Gittell, 2009). On this basis, it is assumed that *perceived trustworthiness* and *appreciation within the team* have a positive effect on the epistemic processes of *mutual learning* and *knowledge integration*.

2.2.3. Organisational integration: collective ownership of goals

Finally, integrative research and development calls for high levels of participation and shared ownership of processes and outcomes (Elzinga, 2008; Lang et al., 2012). Therefore, actors across different organisations and professions need to establish arrangements that not only allow but encourage active involvement (Bronstein, 2002). Participatory organisational arrangements are understood to level power asymmetries and thus provide equal opportunities to express experiences and needs. Against this backdrop, it is assumed that *collective ownership of goals*, understood as the committed involvement in the decision-making process and active participation, moderates the effect from *mutual learning* on *knowledge integration*.

2.2.4. Theoretical framework of transdisciplinary dimensions of integration

Based on the previous outline, Fig. 1 shows a theoretical framework for transdisciplinary dimensions of integration.

2.3. Evaluation context

In order to provide further empirical insights, the outlined evaluative framework was applied to the context of a research and development project located in Lower Saxony, Germany. The project's overarching objective was to generate and establish advancements in school practice and initial teacher education at a regional level through boundary-crossing collaborations. In order to do so, since 2016 eight so-called TDTs have been formed comprising representatives from across the

[1] The article draws in particular on the so-called 'joint problem solving' discourse of transdisciplinarity. For a comprehensive overview see among others Bernstein (2015), Hirsch Hadorn et al. (2008), and Klein (2014).

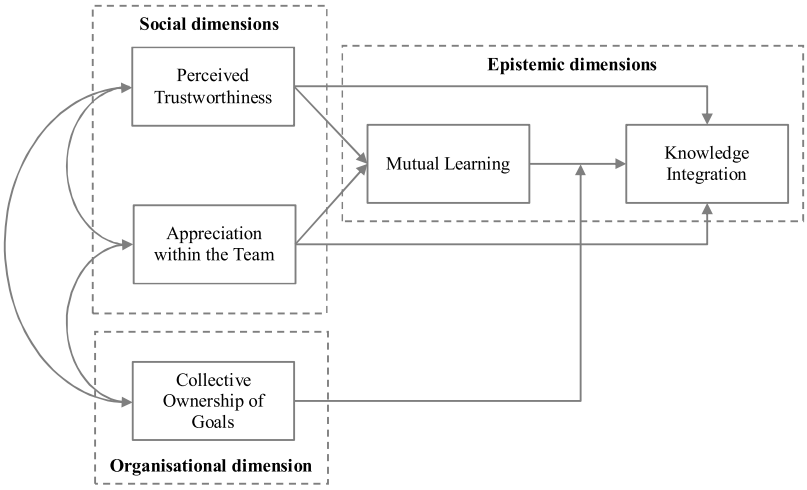

Fig. 1. Theoretical Framework for Transdisciplinary Integration comprising Epistemic, Social, and Organisational Dimensions.

three-staged teacher education system (Straub & Dollereder, 2019). The TDTs address pressing 'hot topics' in teacher education such as competence-oriented instruction, inclusive schooling, mentoring pre-service teachers, and maintaining teachers' health. In alignment with focal principles of transdisciplinarity, the TDTs aim to provide outcomes for a wide range of stakeholder groups. Therefore, each team jointly co-constructs and revises innovative teaching arrangements and materials for both, university-based teacher education as well as local schools.

The TDT concept is understood as a collaborative approach to foster innovation and educational change in school-based teaching and university-based teacher education (Straub & Vilsmaier, 2020). In that way, it resonates with other pertinent conceptualisations such as *Third Space* (Zeichner, 2010) or *Research-Practice Partnerships* (Coburn & Penuel, 2016). TDTs highlight, for instance, the necessity for mutual recognition as well as comprehensive negotiations and shared decision-making processes, which are typical features for *Third Spaces* (Hedges, 2010). On the other hand, TDTs try to balance the dialogue-based openness of *Third Spaces* with programmatic principles of Research-Practice Partnerships (Coburn & Penuel, 2016; Penuel & Gallagher, 2017). In this regard, TDTs are committed to the following characteristics: 1) pursuing a long-term orientation, 2) fostering practical advancements in school practice and initial teacher education, 3) integrating a multi-stakeholder perspective, 4) applying intentional cooperation strategies, and 5) engaging in research-based development (Straub, Dollereder, Ehmke, Leiss, & Schmidt, 2020).

In practice, the TDTs comprise a wide range of stakeholder groups, which are situated in the context of initial teacher education for primary or lower-secondary schools. Each team consists of at least representatives from schools and university, which are understood as focal institutions representing educational practice and research respectively. In addition, there are also further stakeholder groups involved such as student teachers, teacher educators from teacher education institutes as well as partners from educational authorities and extra-curricular institutions. The factual TDT composition, team size, and work organisation vary in accordance with the problem framing and objectives, respectively (Straub & Dollereder, 2019).

3. Empirical research questions

Against the theoretical outline, the following empirical research questions have been analysed in this study.

1 How do the team members assess the cooperation in the TDTs with regard to the dimensions of integration characteristics?
2 Does the assessment of the dimensions of integration characteristics differ between focal groups of actors (practitioners, researchers, and student teachers)?
3 Does the empirical data in this study support the theoretically outlined effect relationships for the dimensions of integration characteristics (see Fig. 2)?

With respect to research question (3), Fig. 2 shows a theoretical model for effect relationships among transdisciplinary dimensions of integration characteristics.

The relationships depicted in Fig. 2 reflect the following hypotheses:

- **H1:** *Mutual learning* has a positive effect on *knowledge integration*.
- **H2:** The effect of *mutual learning* on *knowledge integration* is moderated by *collective ownership of goals* indicating the importance of participatory organisational principles.
- **H3:** *Perceived trustworthiness* has a positive effect on *mutual learning*.
- **H4:** *Appreciation within the team* has a positive effect *on mutual learning*.
- **H5:** *Perceived trustworthiness* has a positive effect on *knowledge integration*.
- **H6:** *Appreciation within the team* has a positive effect on *knowledge integration*.

4. Methodology

In order to answer the previously stated research questions, a written survey was conducted in the context of the TDTs. The survey focused on the dimensions of integration characteristics as outlined in Section 'Dimensions of Integration: Epistemic, Social, and Organisational'.

4.1. Sample description

The survey population was defined as the total of TDT members who were participating at least at five TDT meetings at the time of the survey. A full survey was conducted with the resulting $N = 77$ participants. Due to an overall response rate of 80.5 %, a factual sample size of $n = 62$ was realised. Table 1 provides a compact outline of key characteristics describing the overall composition of the TDTs.

The category *actor groups* comprises focal actor groups represented in the sample: *practitioners* (51.6 %), *researchers* (25.8 %), *student teachers* (16.1 %), and *extra-mural partners, and public authorities* (6.5 %). The actual variety of educational backgrounds, organisational affiliations and vocational status are in fact much more diverse. Especially, the subgroup *practitioners* comprises teachers, principals, and teacher

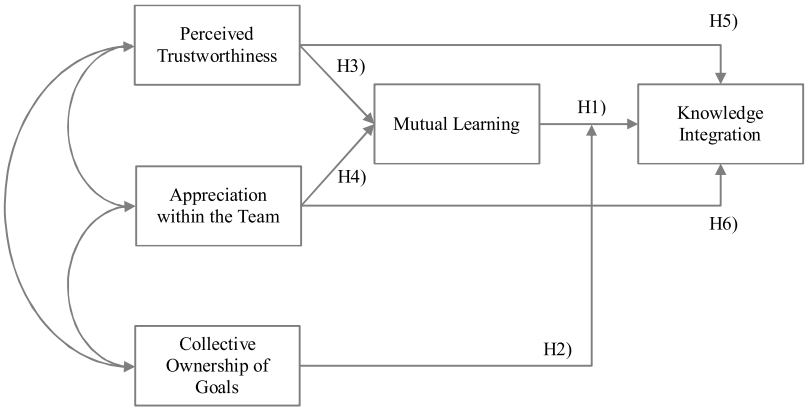

Fig. 2. Effect Relationships between Epistemic, Social, and Organisational Dimensions of Integration Characteristics.

Table 1
Sample Characteristics.

Characteristics	n	%
Actor groups		
Practitioners	32	51.6
Researchers	16	25.8
Student teachers	10	16.1
Extra-mural partners and public authorities	4	6.5
Sex		
Male	14	23.3
Female	46	76.7
Age groups (age in years)		
<30	16	26.7
30–39	18	30.0
40–49	19	31.7
>49	7	11.7
Professional experience (in years)		
0–3	14	22.6
>3–6	14	22.6
>6–10	11	17.7
>10–15	9	14.5
>15	14	22.6
Team size per DT		
Competence-Oriented Mathematics Didactics	8	10.4
Competence-Oriented Music Didactics	6	7.8
Competence-Oriented German Didactics	22	28.6
Competence-Oriented Basic Social and Science Studies	12	15.6
Implementing Inclusion Professionally	7	9.1
Teaching in inclusive English Settings	12	15.6
Mentoring in Practical Studies	4	5.2
Teachers' Health	6	7.8

Note. DT = Development Team. Column n and % refer to valid values only.

educators. The latter are usually experienced teachers who are responsible for preparatory service at teacher education institutes and schools.

The category *researchers* refers to professors and research assistants at the university. *Student teachers* refers to one of the main target groups for the TDTs activities and thus are an important stakeholder group for advancements in teacher education. However, at the time of the survey student teachers participated directly in only two out of eight TDTs which explains their comparably small number in the sample. The category *extra-mural partners and public authorities* refers to partners from local educational institutions, foundations, and public administration. Despite the fact, that they are also considered an important actor group for the joint work in the TDTs, their small number made it not feasible to consider them within the analysis.

With respect to sex, the sample corresponds fairly with active teachers in Lower Saxony in 2016 (male = 27.9 % and female = 72.1 %; MK Niedersachsen, 2018). The *age groups* represented in the TDTs cover the full range from under 30 years to above 59 years. Except for participants over 49 years of age over (11.7 %), the age groups are approximately uniformly distributed. This corresponds also with the overall teacher composition in Lower Saxony (MK Niedersachsen, 2018). In addition, the *professional experience* is likewise approximately equally distributed and reflects various levels of expertise from novice to experienced professionals. Finally, *team size* visualises the variability according to the number of team members (n_i between 4 and 22). In addition, there have been no mandatory requirements for team composition, except for the participation of researchers and teachers, in order to allow for independent and self-reliant team dynamics.

4.2. Survey instrument

A standardised questionnaire used in this study addressed all active TDT members at the time of the survey. Cognitive pre-tests have been conducted prior to the data collection in order to ensure equivalence of meaning (Lenzner, Neuert, & Otto, 2015). This was considered especially important due to the assumed heterogeneity of team members' professional, organisational, and institutional backgrounds. In total nine interviewees participated in the pre-test and represent teachers, student teachers, research assistants, and professors. The questionnaire was modified based on the corresponding feedback.

With regard to the main survey to the members of the TDTs, the questionnaire and a return envelope were sent by mail. In addition, non-personalised reminders were sent via an email distribution list in order to improve the overall response rate.

Based on the theoretical outline, five scales have been used to operationalise the dimensions of integration characteristics. All scales were applied with a six-point Likert scale ranging from 1 = 'does not apply at all' to 6 = 'applies fully'. The questionnaire was conducted in German. Thus, the authors translated the following scales from English: *mutual learning*, *perceived trustworthiness*, *appreciation within the team,* and *collective ownership of goals.* In addition, scales with respect to *knowledge integration* and *collective ownership of goals* have been slightly adapted in order to capture collaborations across different professional backgrounds and organisational affiliations.

For covering *mutual learning* a scale developed by van den Bossche, Gijselaers, Segers, Woltjer, and Kirschner (2011) was applied, originally labelled *team learning behaviours.* In alignment with the theoretical outline, it addresses aspects of collective learning processes in professional workgroups. The scale consists of three sub-scales: *construction*, *co-construction,* and *constructive conflict*. *Construction* addresses aspects of sharing ideas and experiences supported by active listening, whereas *co-construction* refers to the further development of these contributions by adding other perspectives and seeking in-depth clarification.

Constructive conflict comprises the ability to engage in productive discussions by addressing controversial aspects and asking critical questions. Example items for these sub-constructs are: '*Team members are listening carefully to each other*' (*construction*), '*Team members draw conclusions from the ideas that are discussed in the team*' (*co-construction*), and '*Opinions and ideas of team members are verified by asking each other critical* questions' (*constructive conflict*). In accordance with van den Bossche et al. (2011), the sub-scales have been applied together in order to display the main construct of *mutual learning* as an overarching construct.

Knowledge Integration (Steinheider, Bayerl, Menold, & Bromme, 2009) aims at the establishment of shared understandings or mental models about the issue at hand, relevant methodologies, and desired outcomes. Informed by linguistic contributions by Clark and Murphy (1982), Clark (1996), Steinheider et al. (2009) distinguish between two mechanisms to generate these shared frameworks of reference and mental models: *audience design* and *common ground*. *Audience design* allows team members to make their own perspectives understood, whereas *common ground* represents joint understandings according to theoretical-conceptual, methodological, and outcome related aspects of teamwork. Example items are: '*The team members are willing to engage oneself with other perspectives*' (audience design) and '*The team composition from different professional backgrounds complicate the development of shared understanding for cooperation*' (*common ground*, inverted item). Again, both sub-scales were applied together to construct the main scale *knowledge integration*.

With regard to the social dimension of integration, scales for *perceived trustworthiness* and *appreciation within the team* have been applied. *Perceived Trustworthiness* (Costa & Anderson, 2011) provides insights about the integrity within the team and thus informs whether actors rely on their fellow team members. An example item reads: '*In this team, people will keep their word*'.

Appreciation within the team indicates to what extent the teamwork is characterised by mutual recognition. It also indicates the approval and acceptance of opinions despite their different professional backgrounds. The scale was adapted from a similar construct, psychological safety (Carmeli & Gittell, 2009), that fosters open exchange of ideas and explores alternative approaches. An example item is: '*If someone in the team has a fundamentally different opinion, we appreciate it too*'.

Finally, the organisational outline of the teamwork is captured by the scale of *collective ownership of goals* (Bronstein, 2002). It represents whether responsibilities to achieve the shared goals are distributed to all team members and to what extent they are participating in the decision-making processes. An example item is: '*When team members make decisions together, they go through a process of examining alternatives*'.

Table 2 shows basic scale characteristics including the total number of items and internal consistency. Due to unsatisfactory item reliability, two items have been removed from *knowledge integration* and one from collective *ownership of goals*. After adjustments, Cronbach's alpha ranged from $\alpha = .66$ to .88 and indicate (barely) acceptable to good internal constancies, respectively.

Table 2
Measures, Number of Items and Cronbach's α for Dimensions of Integration Characteristics.

Dimensions	Characteristic	No. of Items	Cronbach's α
Epistemic	mutual learning	9	.88
	knowledge integration	6	.66
Social	perceived trustworthiness	6	.74
	appreciation within the team	4	.72
Organisational	collective ownership of goals	6	.71

4.3. Methods of analysis

In order to answer research question (1), whether the development team member assesses the cooperation as being integrative with respect to epistemic, social, and organisational dimensions of integration characteristics descriptive statistics and correlation coefficients have been calculated in IBM SPSS Statistics 25. With reference to research question (2), whether there are statistically significant differences between the actor groups according to epistemic, social, and organisational aspects of dimensions of integration, a one-way ANOVA has been conducted. In order to compose comparable groups, the analysis focuses on practitioners, researchers, and student teachers. These groups are considered to represent relevant professional backgrounds in teacher education. Moreover, Kolmogorov-Smirnov tests indicate non-normal distributed data for all characteristics, except for *mutual learning*, with $p < .05$. Despite that fact, the application of ANOVA was considered feasible, based on recent publications arguing that ANOVA count as robust against violation of non-normal distributed data (Schmider, Ziegler, Danay, Beyer, & Bühner, 2010), even in the case of unbalanced groups and small sub-group sample sizes (Blanca, Alarcón, Arnau, Bono, & Bendayan, 2017). Homogeneity of variances was assessed using Levene's tests. The resulting *p*-values range between .10 and .60 and indicate that equal variances could be assumed. In order to answer research question (3), a manifest path model was calculated in Mplus 7.4.

5. Findings

5.1. Assessment of dimensions of integration characteristics

5.1.1. General assessment of dimensions of integration characteristics

Table 3 shows descriptive statistics and correlation coefficients for the dimensions of integration characteristics within the overall sample. All variables had high mean values and reached the theoretical maximum of 6. The minimum values were all above the theoretical middle of 3.5, except for *collective ownership of goals* ($Min = 2.83$). In addition, the values for standard deviation indicate moderate to high differences in response behaviour. Especially, the standard deviation for *collective ownership of goals* with $SD = .70$ is considered high. The correlation coefficients indicate medium to high correlations with r ranging between .38 and .68.

According to research question (1), the high values for the dimensions of integration characteristics indicate that the TDT members assess the collaboration to be integrative with respect to its epistemic, social, and organisational facets. In general, this provides some empirical evidence that the given collaborative format is considered suitable for cultivating boundary-crossing endeavours in teacher education.

5.1.2. Group differences for dimensions of integration characteristics

In order to answer research question (2), whether the main actor groups practitioners, researchers, and student teachers show differences according to their assessment of the dimensions of integration characteristics, a one-way ANOVA has been calculated. Table 4 shows that there are no statistically significant differences to be found, with *p*-values $> .05$. This result is also reflected through the effect sizes, which indicate none to small effects with ω^2 between .01 and .02.

Nonetheless, further inspection of multiple post-hoc comparisons suggests some descriptive differences between the actor groups (see Table 5). This allows for a tentative discussion of practical implications for the analysed TDTs.

In general, the assessments of *mutual learning*, *knowledge integration,* and *perceived trustworthiness* tend to follow a similar pattern: there are no differences between practitioners and researchers while the differences between practitioners and student teachers as well as researchers and student teachers are small to medium. In some more detail, there is no difference between practitioners and researchers according to *mutual learning* ($d_s = |0.02|$), while student teachers and researchers ($d_s = |0.68|$)

Table 3
Descriptive Statistics and Correlation Coefficients for Dimensions of Integration Characteristics.

Characteristic	Min	Max	M	SD	(1)	(2)	(3)	(4)	(5)
(1) Mutual learning	3.67	6.00	5.37	.53	-				
(2) Knowledge integration	4.17	6.00	5.12	.50	.68	-			
(3) Perceived trustworthiness	4.00	6.00	5.27	.56	.67	.51	-		
(4) Appreciation within the team	3.75	6.00	5.28	.57	.65	.54	.52	-	
(5) Collective ownership of goals	2.83	6.00	4.86	.70	.39	.51	.38	.52	-

Notes. Min = Minimum, *Max* = Maximum, *M* = Mean, *SD* = Standard Deviation.

Table 4
Means, Standard Deviations, and One-Way ANOVA for Dimensions of Integration Characteristics.

Measure	Practitioners ($n = 30$)		Researchers ($n = 16$)		Students ($n = 10$)		$F(2,55)$	p	ω^2
	M	*SD*	*M*	*SD*	*M*	*SD*			
Mutual learning	5.33	.54	5.34	.53	5.66	.32	1.66	.20	.02
Knowledge integration	5.09	.47	5.1	.48	5.33	.57	0.95	.39	.00
Perceived trustworthiness	5.25	.50	5.2	.63	5.52	.49	1.19	.31	.01
Appreciation within the team	5.21	.62	5.45	.43	5.45	.47	1.39	.26	.01
Collective ownership of goals	4.95	.62	4.63	.83	5.07	.64	1.61	.21	.02

Note. ω^2 = omega squared.

Table 5
Post-hoc Analysis for Group Differences according to Dimensions of Integration Characteristics.

	comparison	MD	df	t	p	ds
Mutual learning	1 & 2	−0.01	44	−0.08	1.00	−0.02
	2 & 3	−0.32	24	−1.68	.39	−0.68
	3 & 1	0.33	38	1.80	.25	0.66
Knowledge integration	1 & 2	−0.01	44	−0.07	1.00	−0.02
	2 & 3	−0.23	24	−1.10	.76	−0.44
	3 & 1	0.24	38	1.32	.18	0.48
Perceived trustworthiness	1 & 2	0.05	44	0.32	1.00	0.10
	2 & 3	−0.32	24	−1.36	.44	−0.55
	3 & 1	0.26	38	1.46	.55	0.53
Appreciation within the team	1 & 2	−0.24	44	−1.41	.46	−0.44
	2 & 3	0.00	24	0.02	1.00	0.01
	3 & 1	0.24	38	1.13	.69	0.41
Collective ownership of goals	1 & 2	0.32	44	1.48	.42	0.46
	2 & 3	−0.44	24	−1.44	.35	−0.58
	3 & 1	0.12	38	0.54	1.00	0.20

Notes. Numbers in the column 'comparison' indicate actor groups with 1 = practitioners, 2 = researchers, and 3 = student teachers. MD = mean difference; ds = Cohen's d with pooled standard deviation.

as well as student teachers and practitioners (d_s= |0.66|) show medium effect sizes, respectively. With regard to *knowledge integration*, there is again no difference between practitioners and researchers to be found (d_s= |0.02|). However, there are small differences between student teachers and researchers (d_s= |0.44|) as well as between student teachers and practitioners (d_s= |0.48|). Similar applies for *perceived trustworthiness*, where practitioners and researchers show no differences (d_s= |0.10|), while student teachers and researchers (d_s= |0.55|) show medium differences just as student teachers and practitioners (d_s= |0.53|).

This pattern does not hold true for the assessment of *appreciation within the team* and *collective ownership of goals*, however. Regarding *appreciation within the team,* the assessment by researchers and student teachers are presumably the same (d_s= |0.01|), while practitioners and researchers show small differences (d_s= |0.44|) as well as practitioners and student teachers (d_s= |0.41|).

Finally, concerning *collective ownership of goals,* all groups show some differences from another. In detail, there is a small difference between practitioners and student teachers (d_s= |0.20|). There is also a small to medium difference between practitioners and researchers (d_s= |0.46|), while the difference between researchers and student teachers is again medium (d_s= |0.58|).

Subsequently, the overall ANOVA suggests that there are no fundamental differences in the assessment of the dimensions of integration characteristics to be found. This substantiates the underlying assumption that TDTs are a collaborative format which allow relevant actor groups such as practitioners, researchers, and student teachers to participate at the epistemic, social, and organisational level. However, post-hoc testing provides some further insights for the practical implementation of TDT work.

5.2. Effect relationships among dimensions of integration characteristics

With respect to research question (3), the effect relationships between epistemic, social, and organisational dimensions of integration characteristics, a manifest path model was calculated (see Fig. 3). All variables show standardised values and base on a bootstrapping method with 10,000 replications. In order to calculate a moderation effect between *mutual learning* and *collective ownership of goals* on *knowledge integration* centred mean values have been used. The model fit indicators are considered acceptable with $Chi^2(4) = 4.60$; $p = .33$, $n = 60$; RMSEA = .05; CFI = .99; TLI = .99; SRMR = .06.

According to hypothesis H1, the model indicates that *mutual learning* has a positive effect on *knowledge integration* ($\beta_1 = .57$, $p < .01$). In alignment with hypothesis H2, this relation is positively moderated by *collective ownership of goals*. The effect from *collective ownership of goals* on *knowledge integration* is considered medium ($\beta_2 = .31$, $p < .05$), while the interaction effect between *collective ownership of goals* and *mutual learning* on *knowledge integration* tend to be small (β_2, interact = .16, $p < .05$). Moreover, with respect to hypotheses H3 and H4 *perceived trustworthiness* ($\beta_3 = .46$, $p < .05$) and *appreciation within the team* ($\beta_4 = .42$, $p < .05$) have a medium effect on *mutual learning*.

For hypotheses H5 and H6, the findings indicate a slightly differing picture. The direct effects on *knowledge integration* are none for both, *perceived trustworthiness* ($\beta_{5,\ direct} = -.02$, $p > .05$) and *appreciation within the team* ($\beta_{6,\ direct} = .02$, $p > .05$). However, the results of a mediation analysis (see Table 6) show that both social integration characteristics have indirect effects on *knowledge integration.* These effects are fully mediated by *mutual learning*. For *perceived trustworthiness*, the resulting total effect is considered small ($\beta_{5,\ total} = .24$, $p < .05$). This holds also

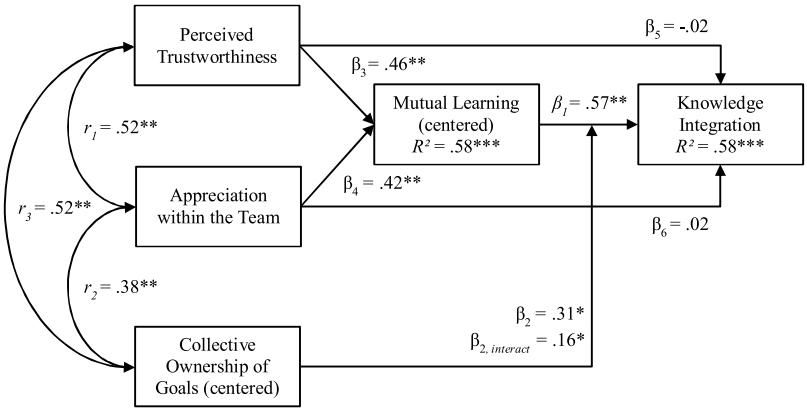

Fig. 3. Manifest Path Model on Effect Relationships between Epistemic, Social, and Organisational Dimension of Integration Characteristics.
Note. r = correlation factor, β = standardised regression coefficient, R^2 = explained variance,
* = p < .05; ** = p < .01; *** = p < .001.

Table 6
Standardised Regression Coefficients for Dimensions of Integration Characteristics.

	β_{direct}	$\beta_{indirect}$	β_{total}
(1) on (3) mediated by (4)	−.02	.26**	.24*
(2) on (3) mediated by (4)	.02	.24**	.25*

Notes. The numbers in brackets refer to respective dimensions of integration characteristics: (1) = perceived trustworthiness, (2) = appreciation within the team, (3) = knowledge integration, and (4) = mutual learning.
* =$p < .05$.
** =$p < .01$.

true for *appreciation within the team* ($\beta_{6,\ total} = .25$, $p < .05$).

Finally, the explained variance of 58 % for both dependent variables *mutual learning* and *knowledge integration* is considered high.

6. Discussion and outlook

This study contributes to the research on and development of collaborative formats at the boundary of school practice and initial teacher education. First, an evaluative framework for the assessment of boundary-crossing collaboration was developed that is inspired by the 'joint problem-solving' discourse of transdisciplinarity. Second, the application of this framework to the TDTs empirically substantiates its potentials for the analysis of collaborative formats among practitioners, researchers, and student teachers. Third, the study also offers implications for further research and practice of boundary-crossing collaboration in school-based teaching and university-based teacher education. The following subsections provide further discussion and outlook on these issues.

6.1. Scientific significance of the study

6.1.1. Theoretical contributions

Despite the increasing attention towards boundary-crossing collaborations in school-based teaching and initial teacher education, especially quantitative evaluative frameworks have been missing so far. The present study addresses this research gap by offering a theoretical framework that draws on the discourse of transdisciplinarity. With respect to teacher education, transdisciplinarity has been primarily discussed in the context of education for sustainable development and in the field of 'Basic Social and Science Studies', a teaching subject at German and Swiss primary schools (Bürgener & Barth, 2018; Künzli David, Gysin, & Bertschy, 2016). In this way, the study also focuses on the application of transdisciplinarity in particular with regard to the analysis of boundary-crossing collaborations in school practice and initial teacher education.

The evaluative framework was in particular inspired by the multi-dimensional understanding of integration (Jahn et al., 2012; Lang et al., 2012) as a constituting factor for in-depth collaboration and co-constructive processes among different actor groups such as practitioners, researchers, and student teachers. In accordance with that understanding, the framework combines (1) epistemic, (2) social, and (3) organisational dimensions of integration characteristics, which have been operationalised in terms of (1a) *mutual learning*, (1b) *knowledge integration*, (2a) *perceived trustworthiness*, (2b) *appreciation within the team,* and (3a) *collective ownership of goals.*

Subsequently, the study contributes according to three theoretical aspects. First, this generic multi-dimensional integration perspective is compatible with pertinent conceptualisations for boundary-crossing collaboration in school practice and university-based teacher education such as, for instance, Research-Practice Partnerships (Straub & Dollereder, 2019; Straub et al., 2020). Second, however, it exceeds the current state of the discussion by drawing the attention towards the systematic analysis of different yet equally relevant dimensions of integration for collaboration among different stakeholder groups in school-based teaching and university-based teacher education. Third, the study used concrete measurement constructs that allowed to further differentiate their interdependencies on a theoretical and empirical level as well.

6.1.2. Empirical insights

The combined findings on research questions (1) and (2) indicate that the TDTs promote integrative collaboration across institutional and organisational boundaries in school practice and initial teacher education. This substantiates also the theoretical conceptualisation of TDT including its programmatic focus and guiding principles (Straub & Vilsmaier, 2020; Straub et al., 2020).

First, based on the high average approval rates (questions 1) the team members consider the boundary-crossing teamwork as integrative with respect to all epistemic, social, and organisational dimensions of integration characteristics. In accordance with that, it can be assumed that the joint development of teaching concepts and materials bases on a shared understanding and co-constructive processes. Moreover, the findings suggest that teamwork was also supported by trusting and appreciative relationships and based on shared decision-making and responsibility (*collective ownership of goals*).

Second, the results on research question (2) indicate that none of the focal actor groups were systematically neglected or shut out throughout the teamwork. In alignment with basic assumptions of transdisciplinarity, this is understood as a crucial indicator for participation

on an equal footing and the co-construction of 'socially robust knowledge' (Nowotny et al., 2001). In consequence, this indicates that the teaching concepts and materials developed within the TDTs are more likely to balance quality criteria in academia (scientific credibility) as well as the practical field (practical relevance).

Finally, findings related to research question (3) empirically substantiated assumed effect relationships in the TDT context. In this way, the study helps to further differentiate the theoretical understanding of relevant impact factors and their interrelation for boundary-crossing collaboration. In particular, *mutual learning* and *knowledge integration* are often used interchangeably (Scholz, 2001; Vilsmaier et al., 2015), which especially hampers empirical analyses. Thus, the conceptual distinction between *mutual learning* as a behavioural capacity that effects *knowledge integration* provides a more differentiated perspective on the epistemic process. In addition, various approaches in teacher education highlight the relevance of social factors, especially mutual trust, as a prerequisite for co-constructive collaboration (Hedges, 2010; Sewell et al., 2018). However, to the authors' knowledge, the interrelation between *trust* and *appreciation* and their effect on epistemic characteristics, such as *mutual learning* and *knowledge integration*, have not been quantitatively analysed so far. This holds also true for the moderating influence of *collective ownership of goals* in terms of participation and shared decision-making. In that way, the study helped to differentiate the effect relationships between focal dimensions of integration characteristics.

6.2. Implications for practice

The supplementing results of the multiple post-hoc comparisons indicate tentative implications for the current practice of the TDT work. First, student teachers show the highest mean values on all dimensions of integration characteristics in comparison to researchers and practitioners. This is understood as student teachers' approval of teaching arrangement which offer learning opportunities relating academic knowledge with practical expertise (Straub & Waschewski, 2019). This interpretation resonates in particular with student teachers' persistent call for more practical studies during initial teacher education (Messner, 2012; Terhart, 2000), which is also a significant driving force for recent reforms pointing at the expansion of practical elements in the first phase in teacher education in Germany (KMK, 2005; Weyland, 2012).

Moreover, practitioners and researchers share similar perceptions according to *mutual learning*, *knowledge integration*, and *perceived trustworthiness*. This can be seen as another clue that TDTs allow (at least to some extent) to mitigate potential status hierarchies and power asymmetries. Moreover, it supports the claim that both actor groups with advanced professional experience benefit likewise from mutual exchange and co-constructive process. This also implies a mutual recognition of practical expertise and scholarly knowledge.

However, the differing picture with respect to *appreciation within the team* and *collective ownership of goals* requires further inquiries. A tentative explanation points to some inherent asymmetries in organisational structures and teamwork dynamics in the TDTs (Straub & Vilsmaier, 2020). Due to the restricted time budgets and the generally resource-intensive teamwork, the majority of organisational, and administrative tasks in terms of meeting preparations, moderation, and documentation lies within the responsibilities of the researchers, especially the research assistants. On the one hand, this results in additional workload whereas, on the other hand, it puts them into a stronger decision-making position (Straub, Spöhrer, & Meimerstorf, 2019). It is assumed that practitioners attribute these differences with respect to a slightly lesser perception of *appreciation within the team*, while researchers articulate the differences in workload with respect to lover ratings of *collective ownership of goals*.

In alignment with the general empirical findings of this study, we draw the tentative conclusion that the TDT work is considered integrative with regard to all dimensions of integration characteristics despite the structural asymmetries within the particular research and development context. To our understanding that is an important insight, since the realisation of boundary-crossing collaborations and its constraints root predominantly in the unequal availability and distribution of resources and capacities (Straub & Vilsmaier, 2020). In that way, the TDT work is understood as an illustrating example for co-constructive collaboration on an equal footing among unequal actors in terms of different expertises, professional obligations, and available time budgets. This reflects on the practical level on how the TDT concept mitigates tensions between the aspirations of openness for multi-stakeholder participation (Third Space) and pragmatic problem-solving orientation (RPPS) (Straub & Vilsmaier, 2020; Straub & Dollereder, 2019).

Inspired by these considerations, a more general proposition is to utilise the epistemic, social and organisational dimensions of integration characteristics not only for summative evaluation but also to stimulate self-reflection during the TDT work. For this purpose, they could be integrated into a jointly composed 'code of conduct' that provides orientation for biannual or annual team meetings in order to reflect on a meta level about the TDTs' performance. This resonates highly with the requirement of RPPs to establish structures and processes that foster cooperative interactions (Straub et al., 2020; Coburn & Penuel, 2016).

6.3. Further research

Despite the theoretical contributions and empirical insights, this study faces some methodical issues typically related to research and development in highly contextualised settings. Boundary-crossing collaborative formats such as the TDTs are locally-bound, context-specific, and resource-intensive which results in a limited number of participating actors and limited sample sizes, respectively. Co-constructive collaboration also requires high degrees of freedom concerning decision-making processes and the design of didactical advancements. In addition, long-term collaboration in inter-organisational settings rely heavily on voluntary commitment which is potentially vulnerable to effects of self-selection and social-desirability.

Methodological suggestions in order to bypass these effects refer usually to randomised controlled trials (RCT) and the use of more objective measures (observations or tests) instead of self-declared attitude surveys (Prenzel, 2010). The application of randomised research designs, however, contradict required voluntary commitment and degrees of freedom. Thus, we discuss alternative suggestions that improve the robustness of the research design and allow for more differentiated research findings.

1) Despite the fact that the particular research context of the TDTs has to be considered quite comprehensive for a project-based and yet long-term collaborative format in terms of involved actors, the factual sample size of $n = 62$ participants still remains a limiting factor for the application of advanced quantitative analyses. A pragmatic approach to mitigating that issue is to increase the data base by applying the proposed evaluative framework to research and development settings similar to the TDTs. This would also allow making comparisons between the different sites in a quasi-experimental multiple-group design (Cohen, Manion, & Morrison, 2018).
2) In order to mitigate ceiling effects and effects of social-desirability it appears promising to apply an item response theory perspective for the development of measurement instrument (Wilson, 2005). Recent studies indicate that positive effects on psychometric measurement properties are also applicable in the case of self-reported attitude assessment (Boone, Staver, & Yale, 2014). In contrast to classical test theory, this also allows to take the difficulty or intensity of the measurement items into account. In addition, the careful reformulation of the items with regard to the prevalence of behavioural aspects instead of directly addressing the intensity of underlying

attitude constructs might have positive impact on measurement quality (Eid & Schmidt, 2014).

3) Despite the overall high approval rates concerning the dimensions of integration characteristics, it is reasonable to assume that especially complex collaborative settings imply also challenging issues which have to be overcome with collective efforts. Thus, further research is needed to differentiate success factors and potentials on the one hand as well as hampering factors and challenges on the other hand. An equally suitable and economic approach to elaborate on both, is to apply standardised questions with open response formats asking for the three most successful as well as the three most challenging aspects of the development team work. For the analysis of the resulting answers, the application of structuring qualitative content analysis deems appropriate (Kuckartz, 2016). In addition, the application of the dimensions of integrations characteristics as deductive category system allows for triangulation strategies or mixed-methods research designs (Kuckartz, 2014).
4) Finally, the present study focused exclusively on the analysis of dimensions of integration characteristics. Thus, further research is needed to link the evaluative framework to outcome related measures indicating, for instance, satisfaction with collaborative teamwork, its usage and usefulness of the developed concepts and materials as well as the wider impact on the involved reference systems, university-based teacher education and school-based teaching.

Declaration of Competing Interest

The authors report no declarations of interest.

Acknowledgements

This work was supported by the Teacher Training Quality Campaign (Qualitätsoffensive Lehrerbildung; grant number: 01JA1603) and the Post Grant Fund (grant number: 16PGF0291), two funding programmes by the German Federal Ministry for Education and Research (BMBF). The funding agency had no influence on study design, collection, analysis and interpretation of data, writing of the report, or publication of the article.

References

Alpert, B., & Bechar, S. (2007). Collaborative evaluation research: A case study of teachers' and academic researcher's teamwork in a secondary school. *Studies in Educational Evaluation, 33*(3–4), 229–257. https://doi.org/10.1016/j.stueduc.2007.07.003.

Bartmann, S., Pfaff, N., & Welter, N. (2012). Vertrauen in der erziehungswissenschaftlichen Forschung [Trust in Educational Research]. *Zeitschrift Für Pädagogik, 58*(6), 772–783.

Bernstein, J. H. (2015). Transdisciplinarity: A review of its origins, development, and current issues. *Journal of Research Practice, 11*(1). http://jrp.icaap.org/index.php/jrp/article/view/510/412.

Blanca, M. J., Alarcón, R., Arnau, J., Bono, R., & Bendayan, R. (2017). Non-normal data: Is ANOVA still a valid option? *Psicothema, 29*(4), 552–557. https://doi.org/10.7334/psicothema2016.383.

Blömeke, S. (2014). Forschung zur Lehrerbildung im internationalen Vergleich [Research in Teacher Education in International Comparison]. In E. Terhart, H. Bennewitz, & M. Rothland (Eds.), *Handbuch der Forschung zum Lehrerberuf* (pp. 441–467). Waxmann.

Rating scale surveys. In Boone, W. J., Staver, J. R., & Yale, M. S. (Eds.), *Rasch analysis in the human sciences*, (pp. 21–46). (2014) (pp. 21–46). Springer. https://doi.org/10.1007/978-94-007-6857-4_2.

Bronstein, L. R. (2002). Index of interdisciplinary collaboration. *Social Work Research, 26*(2), 113–126. https://doi.org/10.1093/swr/26.2.113.

Bürgener, L., & Barth, M. (2018). Sustainability competencies in teacher education: Making teacher education count in everyday school practice. *Journal of Cleaner Production, 174*, 821–826. https://doi.org/10.1016/j.jclepro.2017.10.263.

Carmeli, A., & Gittell, J. H. (2009). High-quality relationships, psychological safety, and learning from failures in work organizations. *Journal of Organizational Behavior, 30*(6), 709–729. https://doi.org/10.1002/job.565.

Clark, H. H. (1996). *Using language*. Cambridge Univ. Press.

Clark, H. H., & Murphy, G. L. (1982). Audience design in meaning and reference. *Advances in Psychology, 9*, 287–299. https://doi.org/10.1016/S0166-4115(09)60059-5.

Coburn, C. E., & Penuel, W. R. (2016). Research–practice partnerships in education: Outcomes, dynamics, and open questions. *Educational Researcher, 45*(1), 48–54. https://doi.org/10.3102/0013189X16631750.

Experiments. In Cohen, L., Manion, L., & Morrison, K. (Eds.), *Research methods in education*, (pp. 391–426). (2018) (pp. 391–426). Routledge.

Costa, A. C., & Anderson, N. (2011). Measuring trust in teams: Development and validation of a multifaceted measure of formative and reflective indicators of team trust. *European Journal of Work and Organizational Psychology, 20*(1), 119–154. https://doi.org/10.1080/13594320903272083.

Eid, M., & Schmidt, K. (2014). *Testtheorie und Testkonstruktion [Test theory and Test construction]*. Hogrefe: Bachelorstudium Psychologie.

Elzinga, A., et al. (2008). Participation. In G. Hirsch-Hadorn, H. Hoffmann-Riem, S. Biber-Klemm, W. Grossenbacher-Mansuy, D. Joye, & C. Pohl (Eds.), *Handbook of transdisciplinary research* (pp. 345–359). Springer Science + Business Media B.V.

European Commission/EACEA/Eurydice. (2015). *The teaching profession in Europe: Practices, perceptions, and policies: Eurydice report*. https://doi.org/10.2797/031792.

Fullan, M. (2016). *The NEW meaning of educational change* (fifth edition). Routledge; Ontario Principals' Council: Teachers College Press.

Godemann, J. (2008). Knowledge integration: A key challenge for transdisciplinary cooperation. *Environmental Education Research, 14*(6), 625–641. https://doi.org/10.1080/13504620802469188.

Gräsel, C. (2011). Die Kooperation von Forschung und Lehrer/innen bei der Realisierung didaktischer Innovationen [The Cooperation between Researchers and Teachers in The Realisation of Didactical Innovations]. In W. Einsiedler (Ed.), *Unterrichtsentwicklung und didaktische Entwicklungsforschung* (pp. 88–101). Klinkhardt.

Hartmann, U., & Decristan, J. (2018). Brokering activities and learning mechanisms at the boundary of educational research and school practice. *Teaching and Teacher Education, 74*, 114–124. https://doi.org/10.1016/j.tate.2018.04.016.

Hedges, H. (2010). Blurring the boundaries: Connecting research, practice and professional learning. *Cambridge Journal of Education, 40*(3), 299–314. https://doi.org/10.1080/0305764X.2010.502884.

Hellmann, K. A. (2018). Kohärenz in der Lehrerbildung – Theoretische Konzeptionalisierung [Coherence in teacher education – theoretical conceptualization]. In K. A. Hellmann, J. Kreutz, M. G. Schwichow, & K. Zaki (Eds.), *Research. Kohärenz in der Lehrerbildung: Theorien, Modelle und empirische Befunde* (pp. 9–30). Springer VS.

Hericks, U. (2004). 3.4 Verzahnung der Phasen der Lehrerbildung [3.4 Interlinking of the Phases in Teacher Education]. In S. Blömeke, P. Reinhold, G. Tulodziecki, & J. Wildt (Eds.), *Handbuch Lehrerbildung* (pp. 301–311). Klinkhardt.

Hirsch Hadorn, G., Biber-Klemm, S., Grossenbacher-Mansuy, W., Hoffmann-Riem, H., Joye, D., Pohl, C., et al. (2008). The emergence of transdisciplinarity as a form of research. In G. Hirsch-Hadorn, H. Hoffmann-Riem, S. Biber-Klemm, W. Grossenbacher-Mansuy, D. Joye, C. Pohl, U. Wiesmann, & E. Zemp (Eds.), *Handbook of transdisciplinary research* (pp. 19–39). Springer Science + Business Media B.V.

Jahn, T., Bergmann, M., & Keil, F. (2012). Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics, 79*, 1–10. https://doi.org/10.1016/j.ecolecon.2012.04.017.

Kleemann, K., Jennek, J., & Vock, M. (Eds.). (2019). *Kooperation von Universität und Schule fördern: Schulen stärken, Lehrerbildung verbessern [Supporting Cooperation of University and School: Strengthen Schools, Improve Teacher Education]*. Verlag Barbara Budrich.

Klein, J. T. (2014). Discourses of transdisciplinarity: Looking back to the future. *Futures, 63*, 68–74. https://doi.org/10.1016/j.futures.2014.08.008.

KMK. (2005). *Eckpunkte für die gegenseitige Anerkennung von Bachelor- und Masterabschlüssen in Studiengängen, mit denen die Bildungsvoraussetzungen für ein Lehramt vermittelt werden [Key Issues of the Mutual Recognition of Bachelor and Master Degree Programmes in Courses of Study that are intended to convey the Educational Prerequisites of Teaching]*. http://www.kmk.org/fileadmin/Dateien/veroeffentlichungen_beschluesse/2005/2005_06_02-Bachelor-Master-Lehramt.pdf.

Kolleck, N., & Bormann, I. (2014). Analyzing trust in innovation networks: Combining quantitative and qualitative techniques of Social Network Analysis. *Zeitschrift Für Erziehungswissenschaft, 17*(S5), 9–27. https://doi.org/10.1007/s11618-014-0551-0.

Kotthoff, H.-G. (2011). Between excellence and equity: The case of the German education system. *Revista Española De Educación Comparada, 18*(0), 27–61.

Kuckartz, U. (2014). *Mixed Methods: Methodologie, Forschungsdesigns und Analyseverfahren [Mixed Methods: Methodology, Research Designs and Applications]*. Springer VS. https://doi.org/10.1007/978-3-531-93267-5.

Kuckartz, U. (2016). Qualitative Inhaltsanalyse: Methoden, Praxis, Computerunterstützung [Qualitative Content Analysis: Methods, Practice, Computational Support] (3., überarbeitete Auflage). *Grundlagentexte Methoden*. Beltz Juventa.

Künzli David, C., Gysin, S., & Bertschy, F. (2016). Sachunterricht als inter- und transdisziplinär konstituiertes Fach: Ansprüche an die Unterrichtsgestaltung und Überlegungen im Hinblick auf die Lehrerinnen- und Lehrerbildung ['Sachunterricht' as an Inter- and Transdisciplinary Constituted Subject]. *Beiträge zur Lehrerinnen- und Lehrerbildung, 34*(3), 305–316.

Kulin, S. (2019). Beziehungen bilden als wesentliches Merkmal von Lehrer/innen-Bildung: Ein Fallbeispiel zu phasen- und institutionenübergreifenden Entwicklungsteams [Building Relationships as an Essential Characteristic of Teacher Education. A Case Study on Phase- and Institution-Crossed Development Teams.]. In U. Graf, & T. Iwers (Eds.), *Beziehungen bilden: Wertschätzende Interaktionsgestaltung in*

pädagogischen Handlungsfeldern. Schriftenreihe zur Humanistischen Pädagogik und Psychologie (pp. 166–178). Klinkhardt.

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., et al. (2012). Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science, 7*(S1), 25–43. https://doi.org/10.1007/s11625-011-0149-x.

Lenzner, T., Neuert, C., & Otto, W. (2015). *Kognitives pretesting.* Mannheim: GESIS - Leibniz Institut für Sozialwissenschaften. https://doi.org/10.15465/gesis-sg_010.

Lillejord, S., & Børte, K. (2016). Partnership in teacher education – A research mapping. *European Journal of Teacher Education, 39*(5), 550–563. https://doi.org/10.1080/02619768.2016.1252911.

Luhmann, N. (2017). *Trust and power.* Polity Press.

Messner, H. (2012). Leitlinien einer phasenübergreifenden Professionalisierung der Lehrerbildung [Guidelines of a Cross-Phased Professionalisation of Teacher Education]. In D. Bosse, L. Criblez, & T. Hascher (Eds.), *Reform der Lehrerbildung in Deutschland, Österreich und der Schweiz. Teil 1: Analysen, Perspektiven und Forschung* (pp. 63–92).

MK Niedersachsen. (2018). *Die niedersächsischen allgemein bildenden Schulen in Zahlen: Stand: Schuljahr 2016/2017 [The Schools of Lower-Saxony in Numbers].* https://www.mk.niedersachsen.de/download/135872/Broschuere_2016_2017_Die_niedersaechsischen_allgemein_bildenden_Schulen_in_Zahlen.pdf.

Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-thinking science: Knowledge and the public in an age of uncertainty (1. Aufl.).* Polity Press.

Penuel, W. R., & Gallagher, D. J. (2017). *Creating research-practice partnerships in education.* Harvard Education Press.

Hybrid Spaces – Zusammenarbeit zwischen Universität, Schulen und Studienseminaren zum Zweck der Lehrerprofessionalisierung [Hybrid Spaces – cooperation between university, schools and study seminars for the purpose of teacher professionalization]. In Pilypaitytė, L., & Siller, H.-S. (Eds.), *Schulpraktische Lehrerprofessionalisierung als Ort der Zusammenarbeit,* (pp. 1–12). (2018) (pp. 1–12). Springer VS.

Postholm, M. B. (2016). Collaboration between teacher educators and schools to enhance development. *European Journal of Teacher Education, 39*(4), 452–470. https://doi.org/10.1080/02619768.2016.1225717.

Prenzel, M. (2010). Geheimnisvoller Transfer? Wie Forschung der Bildungspraxis nützen kann [Mystical Transfer? How Research can be Useful in the Educational Practice]. *Zeitschrift Für Erziehungswissenschaft, 13*(1), 21–37. https://doi.org/10.1007/s11618-010-0114-y.

Schmider, E., Ziegler, M., Danay, E., Beyer, L., & Bühner, M. (2010). Is it really robust? *Methodology, 6*(4), 147–151. https://doi.org/10.1027/1614-2241/a000016.

Scholz, R. W. (2001). The mutual learning sessions. In J. T. Klein, R. Häberli, R. W. Scholz, W. Grossenbacher-Mansuy, A. Bill, & M. Welti (Eds.), *Schwerpunktprogramm Umwelt / Programme Prioritaire Environnement / Priority Programme Environment. Transdisciplinarity: Joint problem solving among science, technology, and society: An effective way for managing complexity* (pp. 117–129). Birkhäuser Basel. https://doi.org/10.1007/978-3-0348-8419-8_11.

Scholz, R. W., & Steiner, G. (2015). The real type and ideal type of transdisciplinary processes: Part I—Theoretical foundations. *Sustainability Science, 10*(4), 527–544. https://doi.org/10.1007/s11625-015-0326-4.

Sewell, A., Cody, T.-L., Weir, K., & Hansen, S. (2018). Innovations at the boundary: An exploratory case study of a New Zealand school-university partnership in initial teacher education. *Asia-Pacific Journal of Teacher Education, 46*(4), 321–339. https://doi.org/10.1080/1359866X.2017.1402294.

Steinheider, B., Bayerl, P. S., Menold, N., & Bromme, R. (2009). Entwicklung und Validierung einer Skala zur Erfassung von Wissensintegrationsproblemen in interdisziplinären Projektteams (WIP) [Development and Validation of a Scale to Identify Problems of Knowledge Integration in Interdisciplinary Project Teams]. *Zeitschrift Für Arbeits- Und Organisationspsychologie A&O, 53*(3), 121–130. https://doi.org/10.1026/0932-4089.53.3.121.

Straub, R., & Dollereder, L. (2019). Transdisziplinäre Entwicklungsteams im ZZL-Netzwerk, Leuphana Universität Lüneburg [Transdisciplinary Development Teams in the ZZL-Network, Leuphana University Lüneburg]. In K. Kleemann, J. Jennek, & M. Vock (Eds.), *Kooperation von Universität und Schule fördern: Schulen stärken, Lehrerbildung verbessern* (pp. 57–82). Verlag: Barbara Budrich. https://doi.org/10.3224/84742209.04.

Straub, R., & Vilsmaier, U. (2020). Pathways to educational change revisited – controversies and advances in the German teacher education system. *Teaching and Teacher Education, 96*, 1–13. https://doi.org/10.1016/j.tate.2020.103140.

Straub, R., & Waschewski, T. (2019). Transdisziplinäre Entwicklungsteams - Lerntheoretische und didaktische Implikationen eines kooperativen Ansatzes zur Theorie-Praxis-Verzahnung in der Lehrkräftebildung [Transdisciplinary Development Teams - Learning Theoretical and Didactical Implications of a Cooperative Approach to the Interlinking in Teacher Education]. In BMBF (Ed.), *Verzahnung von Theorie und Praxis im Lehramtsstudium: Erkenntnisse aus Projekten der „Qualitätsoffensive Lehrerbildung"* (pp. 63–73). Retrieved from: https://www.bmbf.de/upload_filestore/pub/Verzahnung_Theorie_Praxis_Lehramtsstudium_Erkenntnisse_QLB.pdf.

Straub, R., Spöhrer, S., & Meimerstorf, L. (2019). Disziplinen- und phasenübergreifende Kooperation für die Lehrkräftebildung fruchtbar machen: Einsichten aus dem Entwicklungsteam TIES im Kontext inklusiven Englischunterrichts [How to make interdisciplinary and cross-phase cooperation fruitful for teacher education]. In C. Blume, D. Gerlach, N. Benitt, S. Eßer, B. Roters, J. Springob, & T. Schmidt (Eds.), *Perspektiven inklusiven Englischunterrichts: Gemeinsam lehren und lernen.* Retrieved from: https://inklusiver-englischunterricht.de/2019/08/disziplinen-und-phasenuebergreifende-kooperation-fuer-die-lehrkraeftebildung-fruchtbar-machen/.

Straub, R., Dollereder, L., Ehmke, T., Leiss, D., & Schmidt, T. (2020). Research-Practice Partnerships in der Lehrkräftebildung: Potenziale und Herausforderungen am Beispiel institutionen- und phasenübergreifender Entwicklungsteams des ZZL-Netzwerks [Research-practice partnerships in teacher education: Potentials and challenges]. *Beiträge Zur Lehrerinnen-. Und Lehrerbildung, 38*(1), 138–149.

Terhart, E. (2000). *Perspektiven der Lehrerbildung in Deutschland: Abschlussbericht der von der Kultusministerkonferenz eingesetzten Kommission. Beltz Pädagogik.* Beltz.

van den Bossche, P., Gijselaers, W., Segers, M., Woltjer, G., & Kirschner, P. (2011). Team learning: Building shared mental models. *Instructional Science, 39*(3), 283–301. https://doi.org/10.1007/s11251-010-9128-3.

van Schaik, P., Volman, M., Admiraal, W., & Schenke, W. (2019). Approaches to co-construction of knowledge in teacher learning groups. *Teaching and Teacher Education, 84*, 30–43. https://doi.org/10.1016/j.tate.2019.04.019.

Villiger, C., & Trautwein, U. (Eds.). (2015). *Zwischen Theorie und Praxis: Ansprüche und Möglichkeiten in der Lehrer(innen)bildung [Inbetween Theory and Practice. Demands and Possibilities in Teacher Education].* Waxmann.

Vilsmaier, U., Engbers, M., Luthardt, P., Maas-Deipenbrock, R. M., Wunderlich, S., & Scholz, R. W. (2015). Case-based Mutual Learning Sessions: Knowledge integration and transfer in transdisciplinary processes. *Sustainability Science, 10*(4), 563–580. https://doi.org/10.1007/s11625-015-0335-3.

Weyland, U. (2012). *Expertise zu den Praxisphasen in der Lehrerbildung in den Bundesländern [Expertise in Practical Phases of the Teacher Education in the Länder].* https://li.hamburg.de/contentblob/3305538/70560ef5e16d6de60d5d7d159b73322f/data/pdf-studie-praxisphasen-in-der-lehrerbildung.pdf;jsessionid=45499CC1240EB3EB38027EE816A1DBFA.liveWorker2.

Wilson, M. (2005). *Constructing measures: An item response modeling approach.* Lawrence Erlbaum Associates.

Zeichner, K. (2010). Rethinking the connections between campus courses and field experiences in college- and university-based teacher education. *Journal of Teacher Education, 61*(1–2), 89–99. https://doi.org/10.1177/0022487109347671.