Intervention Research Design in the Context of Professionalizing Future Geography Teachers: Specific Potentials of Qualitative and Quantitative Designs Using the Example of Two Empirical Studies

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3.1 The Theory–Practice Problem in the Professionalization of Teachers in German-Language Geography Education

German-language teacher training is often segmented into three distinct phases: First, future teachers begin their training as *students* at university where they study predominantly academic disciplines (usually 4–5 years). Here, they complete some initial practical school training. Second, they undergo practical teacher training as *student teachers* at a school (two years after university degree) before they finally begin their professional careers as *teachers*. In this last phase, teachers periodically take advanced training courses.[1]

There is general agreement that theoretical and practical approaches often do not complement each other ideally in the educational field (Hetfleisch et al., 2017; Rothland, 2020; Wilhelm & Hopf, 2014): Whereas university training (phase 1) seldom

[1] Teacher training varies considerably between Germany, Austria, and Switzerland. Even within Germany for example, there are different manifestations since education is the responsibility of the federal states.

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offers the chance to apply acquired theoretical knowledge and test skills relevant to practice, the more practical phases 2 and 3 rarely resort to scientific knowledge. Hence, synergies hardly ever take effect. Intervention research, however, is a means to bridge this gap within university teacher professionalization efforts as interventions often focus on competences relevant to practice. Corresponding research may identify an intervention's potentials and weaknesses as well as specifically optimize training programs. Accordingly, new and tested training programs emerge from such research and can then be implemented into geography education courses at university to increase their practical relevance. Aside from that, intervention research also produces empirical evidence and contributes to theory building.

Yet, how is it possible to specifically increase practical relevance on the one hand? And what research decisions are relevant to a sound empirical and theoretical foundation on the other? This chapter addresses these questions based on a review of current studies from the last five years of Geography education research by examining the potentials of qualitative and quantitative approaches as well as additional research-methodical decision criteria for practice-oriented intervention research. After that, two current example projects from Geography education research will contextualize how research-methodical decisions can be reached.

3.2 Educational Intervention Research on Professionalizing (Future) Geography Teachers

3.2.1 Qualitative and Quantitative Intervention Research

Educational interventional study designs are a key research approach for bridging the gap between theoretical and practical necessities (Hascher, 2010; Landmann et al., 2010). Such studies always include a so-called *intervention*. Following the definitions of Hager and Hasselhorn (2000) and Leutner (2010), educational interventions are purposeful interferences into prevalent behavioral patterns with the aim to systematically change certain traits, competences, or attributes of individuals within these patterns or they try to modify on a larger scale, e.g., entire systems. In doing that, interventions incorporate at least one method of instruction and one task for the instructed participants. Intervention research focuses on the development of such interventions, their implementation and/or their effects and can have highly heterogeneous designs (Mittag & Bieg, 2010).

In educational research, one pivotal aim of an intervention is often to develop specific classroom competences to tackle certain challenges in the context of learning and teaching (Hascher, 2010; Landmann et al., 2010). Hence, such study designs already set an objective which is particularly relevant for school practice. To be able to make statements about any developments of teachers or pupils respectively, intervention research must apply competence-specific diagnostic methods (Leutner, 2010). When studies also use a sound theoretical and methodological foundation, they can

help to gain scientific knowledge (Landmann et al., 2010). Moreover, interventional designs which are longitudinal and use several instances to gather their data tend to facilitate a deeper understanding of ongoing processes than cross-sectional studies (Dreier et al., 2018; Petermann & Reinelt, 2018). (Quasi-)Experimental designs with control groups can further assist in examining questions of an intervention's efficacy or effectiveness (Döring & Bortz, 2016).

Empirical educational intervention designs in general and within geography education can be classified according to a great diversity of dimensions (Hascher & Schmitz, 2010), e.g., the essential methodological dichotomy of qualitative vs. quantitative. To be precise, qualitative and quantitative research are often assumed to be two extremes within a methodology spectrum; yet they are not necessarily mutually exclusive (Grecu & Völcker, 2018). They can be combined in so-called mixed methods designs (Tashakkori & Cresswell, 2007). Both qualitative and quantitative approaches impose specific requirements for educational intervention research, though (Hascher & Schmitz, 2010).

Qualitative studies are particularly suitable for facilitating exploratory research (Maxwell, 2009) as well as open and unbiased data interpretations (Flick, 1995) through diverse methodical or methodological approaches (Denzin & Lincoln, 1994). With their specific form of data, they can adequately represent the high complexity of authentic school and learning interactions (Firestone, 1993; Hitchcook & Hughes, 1995; Landmann et al., 2010). Qualitative intervention designs have the potential to also capture both a longitudinal process of change and a cross-sectional, in-depth picture at any point during this process (Dreier et al., 2018; Jarsinki, 2014; Thiersch, 2020; Witzel, 2020). Hence, they are widespread in the educational sciences in Germany (Dreier et al., 2018).

Quantitative research designs are typically chosen when research questions or hypotheses are to be examined on many cases with regard to only a few, often already evident aspects (Döring & Bortz, 2016). Consequently, quantitative researchers usually test theories and do that with standardized methods of data collection (Döring & Bortz, 2016). In doing so, quantitative intervention studies can either focus on the perceptions of intervention processes (Abildgaard et al., 2016; Havermans et al., 2016) or on the efficacy and effectiveness of an interventional programme (Döring & Bortz, 2016; Theyßen, 2014).

To make assertions about the ratio of qualitative and quantitative teacher professional development (TPD) intervention studies in German-language geography education, we reviewed publications of Geographiedidaktische Forschungen, the Journal of Geography Education (ZGD), Review of International Geographical Education Online[2] and GW-Unterricht from 2015 until 2020. This timespan was chosen because geography teachers—and teacher education respectively—have come into increased focus in recent years (Hemmer, 2020): In 2015 for example, the Federal Ministry of Education and Research launched the Qualitätsoffensive Lehrerbildung, which aims to strengthen and expand teacher education through a variety of (joint) projects in Germany. In the following, only intervention studies are

[2] Here, we focused on research projects based in German-speaking countries.

included that specifically refer to teachers or future teachers; accordingly, intervention studies on pupils are excluded. The analysis of the sampled intervention studies (Table 3.1; N = 15) shows that the majority focuses on a qualitative orientation (9 of 15), followed by the use of quantitative (3 of 15) and mixed-methods design (3 of 15). Studies predominantly investigate future teachers from the second semester onwards (14 of 15). Practicing teachers are researched very rarely (e.g., Fögele, 2016 and in part von Roux, 2020). Most intervention studies only examine the effects of the intervention on the (future) teachers directly but not potential knock-on effects on the learning processes of the pupils taught by these (future) teachers.

Table 3.1 Reviewed teacher professional development intervention studies in German-language geography education from 2015 until 2020

No.	Authors (year)	methodical focus		
		qualitative	mixed	quantitative
1	Fögele (2016) Fögele (2018)	✓		
2	Brockmüller, Volz & Siegmund (2016)	✓		
3	Schuler, Rosenkränzer, Fanta, Hörsch & Rieß (2016)			✓
4	Applis (2017) Applis (2018)	✓		
5	Maier & Budke (2018)	✓		
6	Pettig & Reinhardt (2018)	✓		
7	Lindau & Renner (2019) Lindau (2020) Renner (2020)	✓		
8	Fögele, Luber & Mehren (2019) Fögele, Luber & Mehren (2020) Luber, Fögele & Mehren (2020)	✓		
9	Budke & Kuckuck (2020)		✓	
10	Dorsch (2020)	✓		
11	Krüger & Hemmer (2020)		✓	
12	Meurel & Hemmer (2020a)			✓
13	Rosendahl, Hemmer & Schrüfer (2020)		✓	
14	von Roux (2020)			✓
15	Streitberger & Ohl (2020)	✓		

3.2.2 Additional Research-Methodical Decision Criteria

Besides the already mentioned *methodology* spectrum of qualitative vs quantitative, there are several research-methodical decision criteria that must be considered (Kromrey et al., 2016). Some are rather fundamental, derived from the *research question* and therefore, usually made at the very beginning of the research process. These include considerations regarding *target group* (e.g., pupils, teachers), *target trait* (e.g., pedagogical content knowledge or map reading skills) and the overall *subject-specific* and *interdisciplinary relevance* of a research project. In the context of intervention research, *practical relevance* takes on importance as well since TPD interventional studies are aimed to bridge the gap between theory and practice. Hence, improving the quality of these studies often also means to strengthen a practice-oriented perspective. Hascher (2010) makes several suggestions for this: objectives could attend to specific practical problems and work towards solutions. Additionally, studies should not only draw on a theoretical foundation but actively seek practical experiences. This could be realized via open communication and cooperation between researchers and practitioners. Ultimately, such exchange could help trickle down scientific results into practice. Most of the reviewed studies show some form of practical relevance; for example, they either work with students in practice-oriented university seminars (e.g., Renner, 2020), (student) teachers in practical teacher training courses (e.g., Fögele, 2016, 2018) or pupils in schools (e.g., Rosendahl et al., 2020).

Likewise, other categories (e.g., timeframe, evaluation focus, scale) determine certain research design decisions but "[do not] necessarily follow by logical deduction from the research question" (Maxwell, 2013, p. 100). While our *Empirical Intervention Study Compass for Subject-Specific Education Research* (Fig. 3.1; Streitberger et al., 2021) summarizes these decisions and simplifies a quick overview on the rationale behind them, the decision criteria will be explained hereinafter. All criteria are based on a critical review of research literature, the sampled studies from the field of geography education (Table 3.1) and own experiences from using intervention study designs.

One crucial decision criterion in the overall planning stages of any intervention study is its timeframe (*timeframe of intervention*). Both short-time and long-time interventions are entirely legitimate. The duration must be carefully tailored to the investigated trait (Hagenauer, 2010; Yoon et al., 2007) and can stretch from few minutes of instruction (short time) to entire school years (long-time) and beyond (Hagenauer, 2010; Hsieh et al., 2005; Landmann et al., 2010; Yoon et al., 2007). While some target traits might be modified by prompts or scaffoldings in short-time interventions (Lin & Lehmann, 1999; Müller & Seufert, 2018), more stable traits might require an enduring modification in prolonged designs (Hagenauer, 2010; Hewson, 2007). Yet, long-time interventions draw on more substantial resources and might mask short-time intervention effects, cause participant fatigue or lead to a higher number of study dropouts (Hagenauer, 2010). Longer time periods might also increase the participants' exposure to confounding factors. Looking at the results

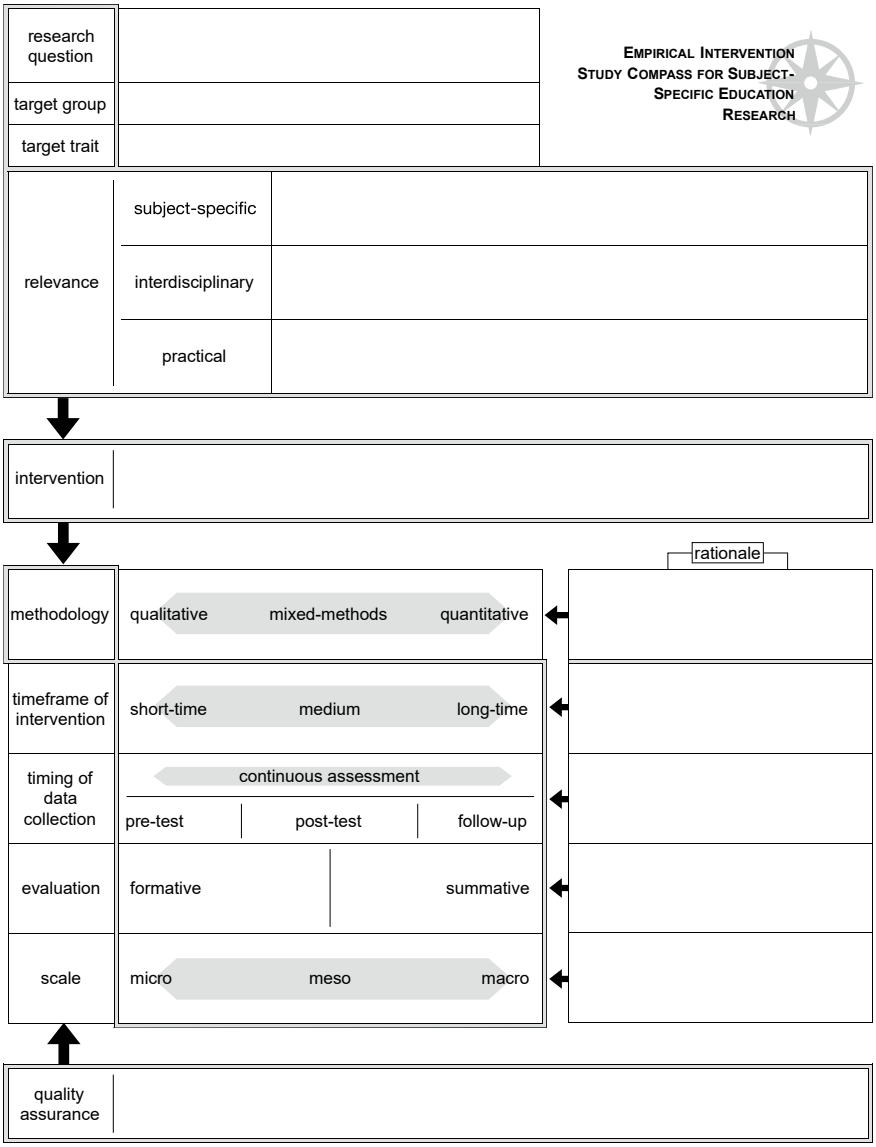

Fig. 3.1 Empirical intervention study compass for subject-specific education research (Streitberger et al., 2021)

from the review, the timeframe of the intervention varies in scope from seven days (e.g., Lindau & Renner, 2019; Luber et al., 2020) to one semester (equivalent to about 4 months, e.g., Meurel & Hemmer, 2020a; Streitberger & Ohl, 2020).

Besides the length of the intervention, time-based decisions are also relevant to data collection (*timing of data collection*). Data collection in intervention studies usually entails at least a pre- and post-intervention assessment (Mittag & Bieg, 2010). Researchers must factor in possible delayed intervention effects (Landmann et al., 2010), necessities to verify the persistence of effects via follow-up tests (Hagenauer, 2010) or topic-specific considerations about the anticipated number of assessments. Often a binary pre-post design without a follow-up assessment is used (e.g., Meurel & Hemmer, 2020a, 2020b; see Schuler et al., 2016 for a counterexample). Rarely, students are asked retrospectively about their intervention experiences without a pre-survey having taken place (e.g., Krüger & Hemmer, 2020). Continuous assessments, which usually consist of several points of data collection during the intervention (Hernández, 2012), are not common (see Renner, 2020 or design-based-research studies Budke & Kuckuck, 2020; Rosendahl et al., 2020; von Roux, 2020 for counterexamples).

Moreover, intervention research must decide on its *evaluation* focus. As the definition above clearly states, change is a central goal of intervention studies. However, it is possible to test for change by either concentrating on a pre-post comparison and conducting a form of summative evaluation or—less frequently—investigate the process of change via formative evaluation (Perels & Otto, 2010). While the former tends to be more resource-efficient and focused on the result, formative evaluations enable a more in-depth analysis of the processes due to a usually larger amount of data and ordinarily integrate feedback loops (Perels & Otto, 2010; Taras, 2005). Formative assessment is thus more common for developing new interventions (Mittag & Bieg, 2010). According to Perels and Otto (2010), it is increasingly common to combine both forms of evaluation in a single intervention study. Design-based research (e.g., Budke & Kuckuck, 2020; Rosendahl et al., 2020; von Roux, 2020), for instance, must incorporate both types of evaluation to some degree to get answers for its typical research questions (Feulner et al., 2015). The review shows a summative emphasis on efficacy and effectiveness of interventions (e.g., Brockmüller et al., 2016), less often on formative aspects of change (e.g., Rosendahl et al., 2020).

Furthermore, interventions differ in their *scale*. They can look at individuals, e.g., teachers, on a micro level at one extreme, to groups of learners (meso level), e.g., in specific professional development courses, to entire systems on a macro level, e.g., with state-wide compulsory trainings during practical teacher trainings (Leutner, 2010). Sustainable TPD requires strong cooperation between different educational agents (e.g., teachers, researchers, and government) and ultimately interventions on all levels (Landmann et al., 2010; Vogt & Scholz, 2020). TPD studies in geography center almost exclusively on students of secondary education (15 of 15). Sample sizes vary depending on the choice of the methodological design from 1 (e.g., Pettig & Reinhardt, 2018) to 151 (e.g., Fögele et al., 2019, 2020; Luber et al., 2020), with 151 being a full survey of the student cohort.

In addition to well-considered design decisions along these criteria, it is also essential to explicitly take steps in securing the quality of a TPD intervention design (*quality assurance*) (Leutner, 2010; Pressley & Harris, 1994). Depending on methodological parameters, quality criteria can encompass explicating design and intervention decisions (Hager & Hasselhorn, 1995; Pressley & Harris, 1994), paying attention to internal and external validity (Crane, 1998; Pressley & Harris, 1994) and a complete and transparent reporting of findings (Pressley & Harris, 1994). Another approach to quality management is proposed by Mittag and Bieg (2010), who distinguish evaluation criteria regarding different stages of intervention studies, namely planning, implementation and success measurement phases.

The following section highlights similar considerations regarding the mentioned design decisions in the context of two more detailed example studies[3] from ongoing research projects on professionalizing future geography teachers at the University of Augsburg to illustrate the rationale behind them.

3.3 Examples from Ongoing Geography Education Intervention Studies and Their Rationale Regarding Research-Methodical Decisions

3.3.1 A Qualitative Perspective: Professionalizing the Vision of Future Geography Teachers with the Use of Video Analysis

An example of a qualitative intervention study from the field of teacher-centered geography education focuses on the professional vision of future geography teachers (Streitberger & Ohl, 2020): To what extent have future geography teachers (*target group*) the ability to perceive geography lessons via video analysis in a professional manner before and after an intervention? Without any topical constraints this *research question* aims at an open and exploratory insight into an inadequately researched section of professional vision (*target trait*) (Lazarevic, 2017), namely geography-education-specific analysis skills (Meurel & Hemmer, 2020b, p. 108). Professional vision, which consists of the process of noticing specific situations relevant to learning and acting on them via knowledge-based reasoning (Seidel & Stürmer, 2014), is,

[3] The presented example studies are integrated in the Augsburg project "LeHet". This project is part of the already mentioned "Qualitätsoffensive Lehrerbildung", a joint initiative of the Federal Government and the Länder which aims to improve the quality of teacher training. The program is funded by the Federal Ministry of Education and Research. The presented example studies are integrated in the Augsburg project "LeHet". This project is part of the already mentioned "Qualitätsoffensive Lehrerbildung", a joint initiative of the Federal Government and the Länder which aims to improve the quality of teacher training. The program is funded by the Federal Ministry of Education and Research.

in turn, considered to be instrumental in adaptive teaching (Hamre et al., 2012; Seidel & Prenzel, 2007). Interventional professionalization efforts regarding professional vision are fruitful (Santagata & Guarino, 2011); geography-specific research, however, is deficient.

With a research question that correspondingly puts changeability and development at its heart, design decisions automatically adapt a longitudinal stance. This is true for many geography educational studies in the context of professionalization (Hemmer, 2020), other educational sciences (Dreier et al., 2018; Hsieh et al., 2005) and typical research designs in the field of professional vision (Scholl & Plöger, 2020). Especially in exploratory research, openness seems to be a necessity (Kromrey et al., 2016). Open, in-depth analyses of the participants' professional vision suggest authentic insights into the complexity of classrooms. Both this realization and the topically unconfined often inductive focus of this study advocate a qualitative approach (*methodology*) (Miles et al., 2020). Carefully considered quantifications are added for the sole purpose of enhancing the exploratory scientific knowledge production (Petermann & Reinelt, 2018) while retaining a qualitative research logic (Krüger, 2010; Miles et al., 2020).

Within this example study both a short-time intervention via a several-minutes-long prompt and a four-month-long intervention are used to broaden the knowledge about the variability of professional vision (*timeframe of intervention*). The short-time intervention is based on an already established, although further compressed lesson analysis framework (see Santagata & Angelici, 2010). In the long-time intervention, which was newly developed and is detailed in Streitberger and Ohl (2021), participants learn to plan lessons theory-based, teach these in authentic classroom situations and systematically analyze video recordings of them afterwards. To secure the intervention's quality, it was evaluated four times by an extended evaluation program and subsequently optimized by analogy with Mittag and Bieg (2010). Both interventions aim to improve the participants' professional vision. While short-time interventions—if satisfactory—might be more efficient and thus more likely to be implemented into practical learning environments, scientific findings often suggest higher effectiveness with longer interventions (Mayer & Fiorella, 2014; Sweller et al., 1998). Regarding professional vision, results indicate timeframes of at least several hours to be able to see professionalization effects (Santagata & Angelici, 2010).

This two-pronged approach illustrates the ambition to do justice to practical and theoretical requirements and becomes also apparent with a research focus that is relevant from a practical and a theoretical point of view—both interdisciplinarily and geography specific (*relevance*; for more information see Fig. 3.2). Thus, it seems natural to consult classroom and research experts at several points during the research process. As described above, participants take part in authentic classroom situations during the interventions and use videos outside of the classroom to further increase its immanent authentic complexity (Sherin, 2004). Additionally, the gathered data is analyzed according to both experience-based (practical) knowledge and science-based (theoretical) knowledge.

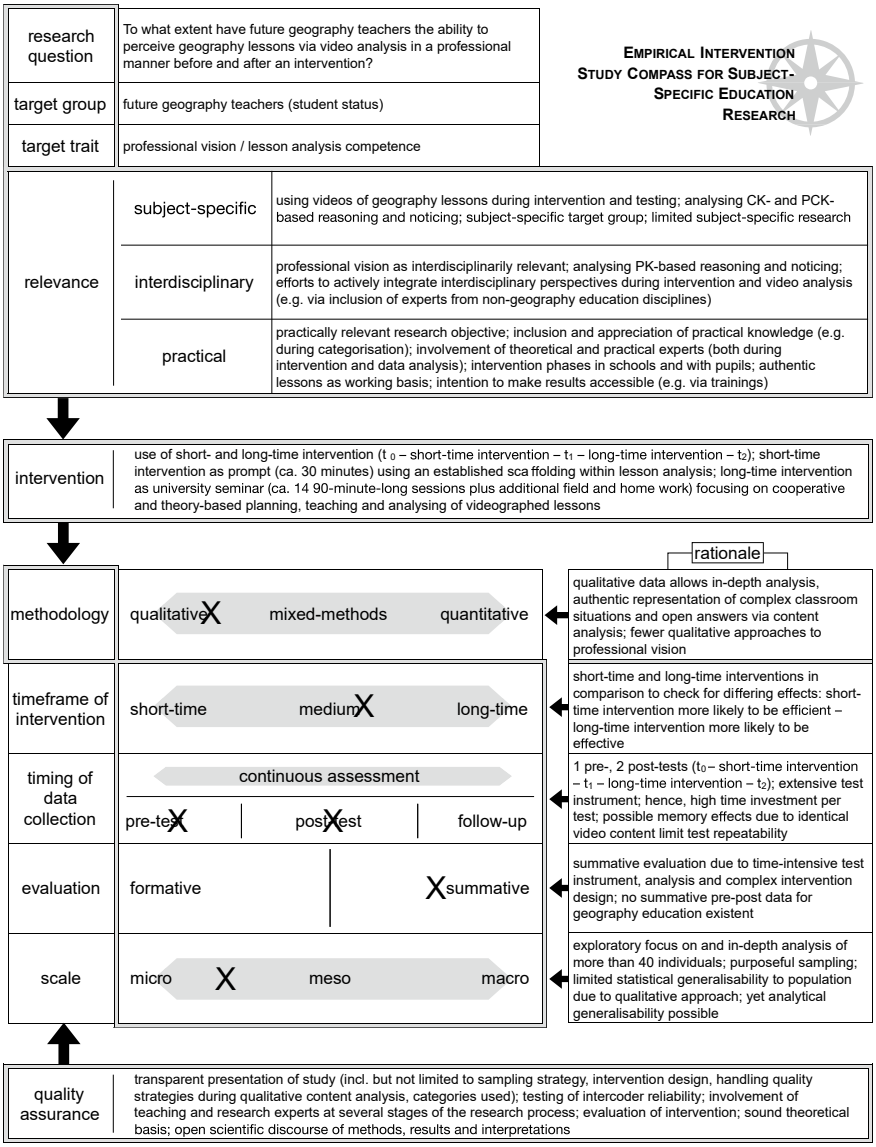

Fig. 3.2 Empirical intervention study compass for geography education research on professionalising the vision of future geography teachers with the use of video analysis (based on Streitberger et al., 2021, research by Sebastian Streitberger)

Data is gathered through three tests (*timing of data collection*), in which participants analyze a videographed lesson segment regarding—in their opinion—anything relevant to learning. The obtained texts are subsequently content-analytically examined with MAXQDA. This sparsely structured test instrument captures sufficiently detailed qualitative data. Yet, it is time- and work-intensive and so complicates a formative evaluation. It uses the same video content for every measurement; with more measurements, which are necessary for formative evaluation, the interval between tests would be shortened and hence, memory effects might influence results (Schwarz et al., 2020). Moreover, the research question with its exploratory emphasis is not directed at detailed development steps but rather interested in fundamental changeability. Therefore, summative assessment (*evaluation*) seems more manageable for a *scale* of more than 40 test subjects over three separate measurements and expedient regarding the research question. With such a sample size within qualitative research, statistical generalizability is "less desirable" (Yin, 2016: 105); analytical generalizability is to be aimed at (Firestone, 1993; Gentles et al., 2015; Yin, 2016). Particularly exploratory studies are allowed to generate data-based working hypotheses without claim of statistical representativity (Mayring, 2007; Yin, 2016).

The here described design decisions have led to a scientifically profound approach to the research question that also incorporates both a practical and resource-conscious perspective. For more information see Fig. 3.2. Preliminary results indicate the intervention's potential to shift the participants' analysis focus onto increasingly relevant classroom situations, e.g., deep structures (Streitberger & Ohl, 2020).

3.3.2 A Quantitative Perspective: Pedagogical Content Knowledge and Beliefs of Future Primary School Teachers from a Geographical Perspective on the Subject Sachunterricht[4]

The quantitative example study is based on the Model of Professional Competence of Teachers (Baumert & Kunter, 2006) and investigates what pedagogical content knowledge and beliefs future primary school teachers have about the geographical perspective of the subject *Sachunterricht* and to what extent they can be changed through university training. It is the second part of the research question which necessitates a quasi-experimental study with pre-, post- and follow-up testing (Döring & Bortz, 2016) since it examines the effects of an intervention measure on the students' beliefs and pedagogical content knowledge.

[4] The subject of Sachunterricht is one of the main subjects in primary school, along with the subjects of mathematics and German in Germany, Austria, and Switzerland. The subject of Sachunterricht is made up of natural, social, historical, technical, and geographical perspectives, which are shown in their interconnectedness. In this way, this subject aims to be compatible with the subjects that follow in secondary school.

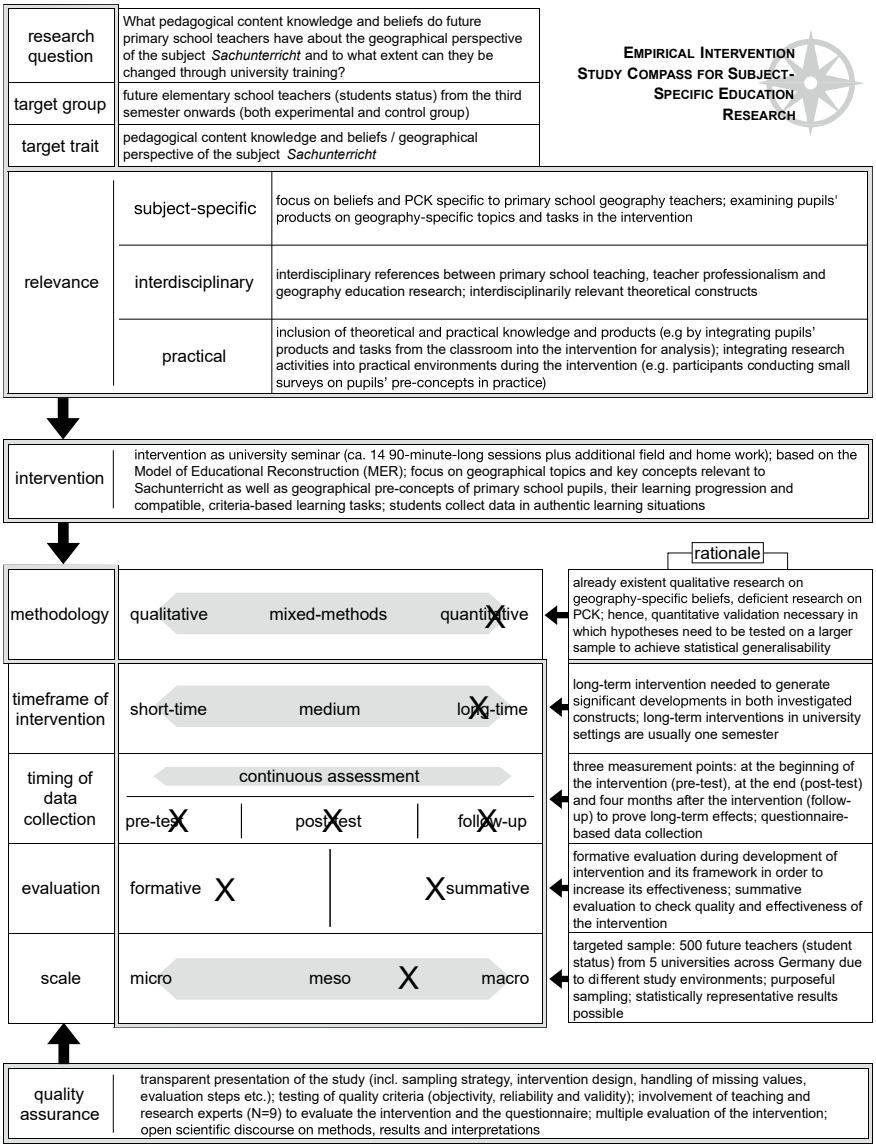

Fig. 3.3 Empirical intervention study compass for geography education research on professionalising the PCK and geography-specific beliefs of future primary school teachers (based on Streitberger et al., 2021, research by Melanie Haltenberger)

The pedagogical content knowledge and beliefs of future primary school teachers from the third semester onwards (N = 500) are assessed by means of questionnaires. The experimental group (N = 250) takes part in a seminar intervention (for more information see Fig. 3.3) on the geographical perspective of Sachunterricht while the

control group (N = 250) attends a standard Sachunterricht seminar. The study aims at differentiating the participants' beliefs and broaden their pedagogical content knowledge through the thorough examination of geographical content knowledge via key concepts (Fögele, 2016) and target-group-specific pedagogical content knowledge.

Pedagogical content knowledge (PCK) as a sub-area of professional knowledge is acquired primarily in the first phase of teacher training (Hartmann, 2018) whereas beliefs are formed predominantly even before or during the student days (Kuhl et al., 2013). A sensitive phase for developing and changing the two constructs is therefore the university teacher training; longer and practice-related intervention programs are recommended (Kleickmann et al., 2017; Pawelzik, 2017). Especially subject-specific courses and the targeted teaching of pedagogical content knowledge have positive effects on the changeability of the constructs (Kleickmann et al., 2017). To differentiate beliefs, which are considered difficult to change (Kuhl et al., 2013), and to generate further developments in PCK (Hartmann, 2018; Kleickmann et al., 2017), a long-term intervention design is needed (*timeframe of intervention*).

A quantitative design (*methodology*) is chosen in order to be able to make standardized statements on beliefs of primary school teachers based on results from already existent qualitative studies (Catling, 2004; Morley, 2012; Öztürk & Alkiş, 2009; Walford, 1996). A statistically representative larger sample is of particular interest (see Fig. 3.3 for more reasons).

Within the three-part quasi-experimental design (*timing of data collection*), the pre-testing survey serves to determine what PCK and beliefs future primary school teachers have because of previous school experiences or basic seminars at university. The aim of the post-intervention survey is to examine the extent to which aspects of professional action competence have changed because of the intervention. A follow-up survey four months after the intervention serves to exclude random effects of the sample and establish long-term effects. Hereby, it is important that the time span between the post-survey and the follow-up survey should be approximately the same as that of the intervention. To be able to ascribe effects only to the experimental group, a control group with similar initial conditions and a similar composition is required. The examined *scale* can be classified as between meso and macro (for reasons see Fig. 3.3).

In this study there is a geography-specific theoretically and practically relevant research focus (*relevance*). The Model of Educational Reconstruction (MER) as well as the inclusion of key concepts proved to be a particularly suitable approach within the framework of the intervention for this purpose (see Fig. 3.3 for more details).

Furthermore, the quality of the questionnaire is ensured through different statistical quality criteria and evaluation steps (*quality assurance*): The objectivity of implementation was ensured by a detailed description of the study procedure and the intervention. The reliability of the questionnaire was checked with item (mean, variance, skewness, kurtosis) and scale analyses (internal consistency, discriminatory power). To validate and operationalize the content of the PCK items, experts (N = 9; professional school experience in total years: 27 years – M = 3.00 years; university experience in years: 54 years – M = 6.75 years) were consulted. Additionally, only those question items were retained that achieved good values in the

assessment of construction quality (e.g., “this task is well constructed and, in my opinion, measures what should be measured”), curricular validity (e.g., “primary school teachers should be able to do this”) and agreement in the expert rating; those with poor values or no agreement were discarded. Aside from that, evaluation studies and specifically developed small accompanying studies helped to optimize the intervention. Four-time formative evaluations served to advance the intervention and its framework in pilot studies to increase its effectiveness. Summative evaluation was used an additional three times here and in the main study twice (*evaluation*).

Results suggest that change in both PCK and beliefs can be induced deliberately through the intervention and the targeted teaching of key concepts. Research decisions which are highlighted in this chapter certainly helped to structure this study and select appropriate quality criteria.

3.4 Summary and Concluding Remarks

The aim of this chapter was to show how researchers can make purposeful research methodical decisions when planning and conducting intervention research projects and in doing so how they can contribute to linking theory and practice in teacher education. Behind this is the overarching goal of honing (future) teachers’ skills which are relevant to practice based on current scientific knowledge.

For this purpose, we have clarified important research methodical criteria and how respective decisions can be made and justified. We did that with reference to the research methodical literature and based on an analysis of intervention studies in geography education from German-speaking countries over the last six years (Table 3.1) as well as two current projects in intervention research.

Our *Empirical Intervention Study Compass for Subject-Specific Education Research* reifies this and can serve a dual function. On the one hand, it is intended to be a helpful tool for planning one’s own intervention research projects by directing one’s attention to central criteria for research methodical decisions and establishing practical relevance. On the other hand, it should make it possible to present research projects and the research methodical rationale behind them in a concise and clear manner. This can result in a profitable transparency of central research methodical decisions. Such transparency can in turn increase intersubjective comprehensibility in empirical research.

As can be seen in the Compass (Figs. 3.1, 3.2, and 3.3), the specific design of an intervention depends on the research question and the associated fundamental decisions regarding target group and target trait. Further fundamental considerations relate to the clarification of the subject-specific, interdisciplinary, and practical relevance of the research project. During the specification of the design, research-methodological decisions (in the spectrum of qualitative and quantitative as well as mixed-methods approaches) play an important role, as do research-methodical decisions (regarding timeframe of intervention, timing of data collection, evaluation,

scale). Quality assurance measures should also be made explicit and included from the outset.

Regarding strengthening the link between theory and practice in the context of intervention research, a variety of possibilities prove to be purposeful. For example, students can develop their own curriculum-relevant teaching concepts with reference to theory, test them in practice, and evaluate their experiences in a video-based manner. Students can also ascertain learning requirements of pupils via inquiry-based learning and develop suitable practical concepts thereafter.

With such interventions, we believe that scientific and practical approaches can pull together to not only make teacher education more motivating but also to increase the practical relevance of scientific activities. Our hope is that such intervention research can contribute substantially to teachers becoming reflective practitioners (Byrne & McRobbie, 1993; Herzog, 1995) who benefit from their abilities to link theory and practice in their everyday professional lives.

Acknowledgements The presented example studies are integrated in the Augsburg project "LeHet". This project is part of the "Qualitätsoffensive Lehrerbildung", a joint initiative of the Federal Government and the Länder which aims to improve the quality of teacher training. The program is funded by the Federal Ministry of Education and Research.

References

Abildgaard, J. S., Saksvik, P. Ø., & Nielsen, K. (2016). How to measure the intervention process? An assessment of qualitative and quantitative approaches to data collection in the process evaluation of organizational interventions. *Frontiers in Psychology, 7*(Art. 1380), 1–10. https://doi.org/10.3389/fpsyg.2016.01380

Applis, S. (2017). Zum Einsatz von Visualisierungen und der besonderen Bedeutung der Einbildungskraft für Erkenntnisprozesse zu Fragen des Fremden. Empirische Ergebnisse dokumentarischer Rekonstruktionen von Vorstellungen von Geographielehrkräften [On the use of visualizations and the special significance of the imagination for cognitive processes on questions of the foreign. Empirical results of documentary reconstructions of geography teachers' beliefs]. In H. Jahnke, A. Schlottmann, & M. Dickel (Eds.), *Räume visualisieren* [Visualising space] (pp. 163–184). readbox unipress.

Applis, S. (2018). Zum Konzept der moralischen Landkarten und seiner Eignung für geographiedidaktische Theoriebildung und empirische Forschung [On the concept of moral maps and its suitability for geographic didactic theory building and empirical research]. *Zeitschrift für Geographiedidaktik - ZGD, 46*(2), 27–50.

Baumert, J., & Kunter, M. (2006). Stichwort: Professionelle Kompetenz von Lehrkräften [Keyword: Professional competence of teachers]. *Zeitschrift für Erziehungswissenschaft, 9*, 469–520. https://doi.org/10.1007/s11618-006-0165-2

Brockmüller, S., Volz, D., & Siegmund, A. (2016). Der Einsatz experimenteller Arbeitsweisen zur Förderung geographischen Systemverständnisses bei Schüler/innen und Lehramtsstudierenden [The use of experimental work methods to promote geographical system understanding among pupils and student teachers]. In K.-H. Otto (Ed.), *Geographie und naturwissenschaftliche Bildung*

- der Beitrag des Faches für Schule, Lernlabor und Hochschule: Dokumentation des 21. HGD-Symposiums im März 2015 in Bochum [Geography and science education—The subject's contribution to schools, learning labs and universities: Documentation of the 21st HGD Symposium in Bochum in March 2015] (pp. 104–123). readbox unipress.

Budke, A., & Kuckuck, M. (2020). Kartenbasierte Argumentationen in der Geographielehrerbildung –eine empirische Untersuchung zur Effizienz von Strukturierungs- und Formulierungshilfen [Map-based argumentation in geography teacher education—An empirical study on the efficiency of structuring and formulation aids]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 177–190). readbox unipress.

Byrne, A., & McRobbie, C. J. (1993). Towards becoming a reflective practitioner: What to know and where to find it. *Research in Science Education, 23*(1), 15–23.

Catling, S. (2004). An understanding of geography: The perspectives of English primary trainee teachers. *GeoJournal, 60*, 149–158. https://doi.org/10.1023/B:GEJO.0000033575.54510.c6

Crane, J. (1998). Building on success. In J. Crane (Ed.), *Social programs that work* (pp. 1–42). Russell Sage Foundation.

Denzin, N. K., & Lincoln, Y. S. (1994). Introduction: Entering the field of qualitative research. In N. K. Denzin, & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 1–17). Sage.

Döring, N., & Bortz, J. (2016). *Forschungsmethoden und Evaluation in den Sozial- und Humanwissenschaften* [Research methods and evaluation in the social and human sciences]. Springer.

Dorsch, C. (2020). Mündig sein in der Kultur der Digitalität – Portfolioarbeit in der geographischen Lehrkräftebildung [Being mature in the culture of digitality—Portfolio work in geographic teacher education]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 277–292). readbox unipress.

Dreier, L., Leuthold-Wergin, A., & Lüdemann, J. (2018). Qualitativer Längsschnitt in der Bildungsforschung [Qualitative longitudinal research in educational research]. In M. S. Maier (Ed.), *Qualitative Bildungsforschung* [Qualitative educational research] (pp. 153–168). Springer VS. https://doi.org/10.1007/978-3-658-18597-8_9

Feulner, B., Ohl, U., & Hörmann, I. (2015). Design-Based Research – ein Ansatz empirischer Forschung und seine Potenziale für die Geographiedidaktik [Design-based research—An empirical research approach and its potentials for geography education]. *Zeitschrift Für Geographiedidaktik, 15*(3), 205–231.

Firestone, W. A. (1993). Alternative arguments for generalizing from data as applied to qualitative research. *Educational Researcher, 22*(4), 16–23.

Flick, U. (1995). Stationen des qualitativen Forschungsprozesses [Stages of a qualitative research process]. In U. Flick, E. von Kardoff, H. Keupp, L. von Rosenstiel, & S. Wolff (Eds.), *Handbuch Qualitative Sozialforschung. Grundlagen, Konzepte, Methoden und Anwendungen* [Handbook on qualitative social research: Basics, concepts, methods and applications] (pp. 147–173). Beltz.

Fögele, J. (2016). *Entwicklung basiskonzeptionellen Verständnisses in geographischen Lehrerfortbildungen: Rekonstruktive Typenbildung, relationale Prozessanalyse, responsive Evaluation* [Developing basic conceptual understanding in geographical teacher training: Reconstructive typification, relational process analysis, responsive evaluation]. Monsenstein und Vannerdat.

Fögele, J. (2018). Lehrertypen im Umgang mit geographischen Basiskonzepten. Rekonstruktion professioneller Überzeugungen von Geographielehrkräften [Teacher types in dealing with basic geographical concepts: Reconstructing professional beliefs of geography teachers]. *Zeitschrift für Geographiedidaktik - ZGD, 46*(1), 3–32.

Fögele, J., Luber, L., & Mehren, R. (2019). Responsive Verfahren zur Selbstreflexion des eigenen Lehramtsstudierendentyps: Ausgewählte Erkenntnisse aus einem Experimentierseminar

[Responsive procedures for self-reflection of one's own student teacher type: Selected findings from an experimental seminar]. *Zeitschrift Für Geographiedidaktik - ZGD, 47*(2), 60–77.

Fögele, J., Luber, L., & Mehren, M. (2020). Orientierungen von Lehramtsstudierenden in der Geographie Rekonstruktion > Responsivität > Reflexion [Orientations of student teachers in geography reconstruction > responsivity > reflection]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 79–92). readbox unipress.

Gentles, S. J., Charles, C., Ploeg, J., & McKibbon, K. A. (2015). Sampling in qualitative research. Insights from an overview of the methods literature. *The Qualitative Report, 20*(11), 1772–1789. http://nsuworks.nova.edu/tqr/vol20/iss11/5

Grecu, A., & Völcker, M. (2018). Mixed Methods. Potenziale und Herausforderungen der Integration qualitativer und quantitativer Forschungsmethoden [Mixed methods: Potentials and challenges of integrating qualitative and quantitative research methods]. In M. S. Maier, C. I. Keßler, U. Deppe, A. Leuthold-Wergin, & S. Sandring (Eds.), *Qualitative Bildungsforschung. Methodische und methodologische Herausforderungen in der Forschungspraxis* [Qualitative educational research: Methodological and methodological challenges in research practice] (pp. 229–246). Springer VS. https://doi.org/10.1007/978-3-658-18597-8

Hagenauer, G. (2010). Kurzzeitinterventionen versus Langzeitinterventionen [Short-time versus long-time interventions]. In T. Hascher, & B. Schmitz (Eds.), *Pädagogische Interventionsforschung. Theoretische Grundlagen und empirisches Handlungswissen* [Educational intervention research: Theoretical foundations and empirical knowledge for action] (pp. 243–251). Juventa.

Hager, W., & Hasselhorn, M. (1995). Konzeption und Evaluation von Programmen zur kognitiven Förderung. Theoretische Überlegungen [Design and evaluation of cognitive enhancement programmes: Theoretical considerations]. In M. Hasselhorn (Ed.), *Programme zur Förderung des Denkens bei Kindern. Konstruktion, Evaluation und Metaevaluation* [Programmes to promote thinking in children: Construction, evaluation and meta-evaluation] (pp. 41–85). Hogrefe.

Hager, W., & Hasselhorn, M. (2000). Psychologische Interventionsmaßnahmen. Was sollen sie bewirken können? [Psychological intervention measures: What are they supposed to be able to achieve?]. In W. Hager, J.-L. Patry, & H. Brezing (Eds.), *Evaluation psychologischer Interventionsmaßnahmen. Standards und Kriterien. Ein Handbuch* [Evaluation of psychological intervention measures: Standards and criteria. A manual] (pp. 41–85). Hans Huber.

Hamre, B. K., Pianta, R. C., Burchinal, M., Field, S., LoCasale-Crouch, J., Downer, J. T., Howes, C., LaParo, K., & Scott-Little, C. (2012). A course on effective teacher-child interactions. *American Educational Research Journal, 49*(1), 88–123. https://doi.org/10.3102/0002831211434596

Hartmann, C. (2018). Zur Bedeutsamkeit formaler Lerngelegenheiten für das fachdidaktische Wissen im Bereich der historischen Perspektive des Sachunterrichts [On the significance of formal learning opportunities for pedagogical content knowledge in the area of the historical perspective of Sachunterricht]. *Zeitschrift Für Grundschulforschung, 11*, 269–284. https://doi.org/10.1007/s42278-018-0016-2

Hascher, T. (2010). Unterschiedliche Interventionsimpulse. Forschungs- versus praxisorientierte Ansätze [Different intervention impulses. Research-oriented versus practice-oriented approaches]. In T. Hascher, & B. Schmitz (Eds.), *Pädagogische Interventionsforschung. Theoretische Grundlagen und empirisches Handlungswissen* [Educational intervention research: Theoretical foundations and empirical knowledge for action] (pp. 269–279). Juventa.

Hascher, T., & Schmitz, B. (2010). Pädagogischer Interventionsforschung. Überblick und Perspektiven [Different intervention impulses: Research versus practice-oriented approaches]. In T. Hascher, & B. Schmitz (Eds.), *Pädagogische Interventionsforschung. Theoretische Grundlagen und empirisches Handlungswissen* [Educational intervention research: Theoretical foundations and empirical knowledge for action] (pp. 7–11). Juventa.

Havermans, B. M., Schelvis, R. M. C., Boot, C. R. L., Brouwers, E. P. M., Anema, J. R., & van der Beek, A. J. (2016). Process variables in organizational stress management intervention evaluation research: A systematic review. *Scandinavian Journal of Work, Environment & Health, 42*(5), 371–381. https://doi.org/10.5271/sjweh.3570

Hemmer, M. (2020). Geographie in der Lehrerinnen- und Lehrerbildung [Geography in teacher education]. In C. Cramer, J. König, M. Rothland, & S. Blömeke (Eds.), *Handbuch Lehrerinnen- und Lehrerbildung* [Handbook on teacher education] (pp. 428–435). Klinkhardt.

Hernández, R. (2012). Does continuous assessment in higher education support student learning? *Higher Education, 64*(4), 489–502. https://doi.org/10.1007/s10734-012-9506-7

Herzog, W. (1995). Reflexive Praktika in der Lehrerinnen- und Lehrerbildung [Reflective internships in teacher education]. *Beiträge Zur Lehrerinnen- Und Lehrerbildung, 13*(3), 253–273.

Hetfleisch, P., Goeze, A., & Schrader, J. (2017). *Wie PraktikerInnen wissenschaftliche Befunde verwenden. Selektions- und Rezeptionsprozesse bei der Implementation eines evidenzbasierten Trainingskonzepts* [How practitioners use scientific findings: Selection and reception processes in the implementation of an evidence-based training concept]. *Zeitschrift für Pädagogik, 63*(2), 182–205.

Hewson, P. W. (2007). Teacher professional development in science. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 1179–1203). Routledge.

Hitchcook, G., & Hughes, D. (1995). *Research and the teacher: A qualitative introduction to school-based research*. Routledge.

Hsieh, P. (Pei-Hsuan), Acee, T., Chung, W.-H., Hsieh, Y.-P., Kim, H., Thomas, G. D., You, J.-i., Levin, J. R., & Robinson, D. H. (2005). Is educational intervention research on the decline? *Journal of Educational Psychology, 97*(4), 523–529. https://doi.org/10.1037/0022-0663.97.4.523

Jarsinki, S. (2014). *Quantitative Datenanalyse zur längsschnittlichen Erfassung der Rechtschreibkompetenz in NEPS unter besonderer Berücksichtigung der Kompetenzstruktur und der Einflussfaktoren* [Quantitative data analysis for the longitudinal recording of spelling competence in NEPS with special consideration of the competence structure and influencing factors]. Dissertation, Technische Universität Dortmund.

Kleickmann, T., Tröbst, S., Heinze, A., Bernholt, A., Rink, R., & Kunter, M. (2017). *Teacher knowledge experiment: Conditions of the development of pedagogical content knowledge* (Methodology of Educational Measurement and Assessment). Springer. https://doi.org/10.1007/978-3-319-50030-0_8. doi:https://doi.org/10.1007/978-3-319-50030-0_8

Kromrey, H., Roose, J., & Strübing, J. (2016). *Empirische Sozialforschung. Modelle und Methoden der standardisierten Datenerhebung und Datenauswertung mit Annotationen aus qualitativ-interpretativer Perspektive* [Empirical social research: Models and methods of standardized data collection and data analysis with annotations from a qualitative-interpretative perspective]. UVK.

Krüger, H.-H. (2010). The importance of qualitative methods in the German educational science. In R. Bohnsack, N. Pfaff, & W. Weller (Eds.), *Qualitative analysis and documentary method: In international educational research* (pp. 53–74). Budrich. https://doi.org/10.3224/86649236

Krüger, S., & Hemmer, M. (2020). Potentiale und Grenzen des Konzepts Praxisprojekte in Kooperationsschulen in der Ersten Phase der Lehrerbildung – aufgezeigt am Beispiel der Förderung der Kartenauswertungskompetenz [Potentials and limitations of the concept of practical projects in cooperation schools in the first phase of teacher training—Shown by the example of promoting map evaluation competence]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 191–206). readbox unipress.

Kuhl, J., Moser, V., Schäfer, L., & Redlich, H. (2013). Zur empirischen Erfassung von Beliefs von Förderschullehrerinnen und -lehrern [On the empirical assessment of beliefs of special education teachers]. *Empirische Sonderpädagogik, 5*(1), 3–24.

Landmann, M., Schmidt, M., & Schmitz, B. (2010). Bildungspsychologische Intervention [Educational psychological interventions]. In C. Spiel, B. Schober, P. Wagner, & R. Reimann (Eds.), *Bildungspsychologie* [Educational psychology] (pp. 301–318). Hogrefe.

Lazarevic, C. (2017). *Professionelle Wahrnehmung und Analyse von Unterricht durch Mathematiklehrkräfte. Eine fallkonstruktive Studie* [Mathematics teachers' professional vision and analysis of teaching: A case-constructive study]. Springer.

Leutner, D. (2010). Perspektiven pädagogischer Interventionsforschung [Perspectives of pedagogical intervention research]. In T. Hascher, & B. Schmitz (Eds.), *Pädagogische Interventionsforschung. Theoretische Grundlagen und empirisches Handlungswissen* [Educational intervention research: Theoretical foundations and empirical knowledge for action] (pp. 63–72). Juventa.

Lin, X., & Lehman, J. D. (1999). Supporting learning of variable control in a computer-based biology environment: Effects of prompting college students to reflect on their own thinking. *Journal of Research in Science Teaching, 36*(7), 837–858.

Lindau, A.-K. (2020). Subjektive Wahrnehmungen von Aspekten der professionellen Handlungskompetenz zu geographischen Exkursionen bei Lehramtsstudierenden – zwei Fallanalysen im Kontext von Gruppendiskussionen [Subjective perceptions of aspects of professional action competence on geographical excursions among student teachers—Two case analyses in the context of group discussions]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 123–136). readbox unipress.

Lindau, A.-K., & Renner, T. (2019). Zur Bedeutung des Fragenstellens bei geographischen Exkursionen [On the importance of asking questions during geographical excursions]. *Zeitschrift Für Geographiedidaktik - ZGD, 47*, 24–44. https://doi.org/10.18452/19954

Luber, L., Fögele, J., & Mehren, R. (2020). How do students experience a deprived urban area in Berlin? Empirical reconstruction of students' orientations. *Review of International Geographical Education - RIGEO, 10*(4), 500–533.

Maier, V. & Budke, A. (2018). Beobachtungsbögen als Medien zur Reflexion über Geographieunterricht. Ergebnisse aus einem deutsch-niederländischen Austauschseminar zum Thema „Raumplanung" [Observation sheets as media for reflection on geography teaching: Results from a German-Dutch exchange seminar on "Spatial Planning"]. In M. Dickel, L. Kessler, F. Pettig, & F. Reinhardt (Eds.), *Grenzen markieren und überschreiten – Positionsbestimmungen im weiten Feld der Geographiedidaktik: Tagungsbeiträge zum HGD-Symposium 2017 in Jena* [Marking and crossing borders—Defining positions in the broad field of geography didactics: Conference contributions to the HGD Symposium 2017 in Jena] (pp. 61–74). Münsterscher Verlag für Wissenschaft.

Maxwell, J. A. (2009). Designing a qualitative study. In L. Bickman, & D. J. Rog (Eds.), *The Sage handbook of applied social research methods* (pp. 214–253). Sage.

Maxwell, J. A. (2013). *Qualitative research design: An interactive approach*. Sage.

Mayer, R. E., & Fiorella, L. (2014). Principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity, and temporal contiguity principles. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 279–315). Cambridge University Press. https://doi.org/10.1017/cbo9781139547369.015

Mayring, P. (2007). Generalisierung in qualitativer Forschung [Generalisations in qualitative research]. *Forum Qualitative Sozialforschung/Forum Qualitative Social Research, 8*(3).

Meurel, M., & Hemmer, M. (2020a). Videobasiertes Lernsetting zur Förderung der professionellen Unterrichtswahrnehmung bei angehenden Geographielehrkräften – erste Ergebnisse einer empirischen Studie [Video-based learning setting for the promotion of professional vision among trainee geography teachers—First results of an empirical study]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the

geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 149–164). readbox unipress.

Meurel, M., & Hemmer, M. (2020b). Geographieunterricht videobasiert analysieren. Konzeption und Evaluation eines videobasierten Lernsettings zur Förderung der professionellen Unterrichtswahrnehmung [Video-based analysis of geography lessons: Conception and evaluation of a video-based learning setting for the promotion of professional vision]. In K. Hauenschild, B. Schmidt-Thieme, D. Wolff, & S. Zourelidis (Eds.), *Videografie in der Lehrer*innenbildung. Aktuelle Zugänge, Herausforderungen und Potenziale* [Videography in teacher education: Current approaches, challenges and potentials] (pp. 106–118). Universitätsverlag Hildesheim. https://doi.org/10.18442/100/10.18442/109

Miles, M. B., Hubermann, A. M., & Saldaña, J. (2020). *Qualitative data analysis: A methods sourcebook*. Sage.

Mittag, W., & Bieg, S. (2010). Die Bedeutung und Funktion pädagogischer Interventionsforschung und deren grundlegende Qualitätskriterien [The importance and function of educational intervention research and its basic quality criteria]. In T. Hascher, & B. Schmitz (Eds.), *Pädagogische Interventionsforschung. Theoretische Grundlagen und empirisches Handlungswissen* [Educational intervention research: Theoretical foundations and empirical knowledge for action] (pp. 31–47). Juventa.

Morley, E. (2012). English primary trainee teachers' perceptions of geography. *International Research in Geographical and Environmental Education, 21*, 123–137. https://doi.org/10.1080/10382046.2012.672678

Müller, N. M., & Seufert, T. (2018). Effects of self-regulation prompts in hypermedia learning on learning performance and self-efficacy. *Learning and Instruction, 58*, 1–11. https://doi.org/10.1016/j.learninstruc.2018.04.011

Öztürk, M., & Alkiş, S. (2009). Primary-school student teachers' perceptions of geography. *Elementary Education Online, 8*(3), 782–797.

Pawelzik, J. (2017). *Zusammenhänge zwischen Überzeugungen von Studierenden zum naturwissenschaftlichen Sachunterricht und praxisbezogenen Lerngelegenheiten eine Studie im Rahmen des Projektes „Integration von Theorie und Praxis – Partnerschulen (ITPP)"* [Connections between students' beliefs about science teaching and practice-based learning opportunities a study within the framework of the project "Integration of Theory and Practice—Partner Schools (ITPP)"]. Universitäts- und Landesbibliothek.

Perels, F., & Otto, B. (2010). Evaluation von Interventionen. Erfassung der Veränderung versus Erfassung des Prozesses? [Evaluation of interventions: Capturing the change versus capturing the process?]. In T. Hascher & B. Schmitz (Eds.), *Pädagogische Interventionsforschung. Theoretische Grundlagen und empirisches Handlungswissen* [Educational intervention research: Theoretical foundations and empirical knowledge for action] (pp. 252–259). Juventa.

Petermann, F., & Reinelt, T. (2018). Veränderungsmessung [Measuring change]. In D. H. Rost, J. R. Sparfeldt, & S. Buch (Eds.), *Handwörterbuch pädagogische Psychologie* [Handbook on pedagocial psychology] (pp. 870–875). Beltz.

Pettig, F., & Reinhardt, F. (2018). Kooperation in der LehrerInnenbildung. Erfahrungen aus einem Seminar von Wirtschaftsgeographie und Didaktik der Geographie [Cooperation in Teacher Education: Experiences from a seminar of economic geography and didactics of geography]. In M. Dickel, L. Kessler, F. Pettig, & F. Reinhardt (Eds.), *Grenzen markieren und überschreiten - Positionsbestimmungen im weiten Feld der Geographiedidaktik: Tagungsbeiträge zum HGD-Symposium 2017 in Jena* [Marking and crossing borders—Defining positions in the broad field of geography didactics: Conference contributions to the HGD Symposium 2017 in Jena] (pp. 75–84). Münsterscher Verlag für Wissenschaft.

Pressley, M., & Harris, K. R. (1994). Increasing the quality of educational intervention research. *Educational Psychology Review, 6*(3), 191–208.

Renner, T. (2020). Selbstwirksamkeitserwartungen bei Lehramtsstudierenden zu geographischen Exkursionen [Self-efficacy expectations of student teachers in relation to geographical excursions]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (1st ed., pp. 109–122). readbox unipress.

Rosendahl, N., Hemmer, M., & Schrüfer, G. (2020). Komplexitätsreduzierte Praxiserfahrung im GEO Lehr-Lern-Laborals Weg der Professionalisierung von Lehramtsstudierenden? Eine Design-Based-Research-Studie zur Entwicklung der Selbstwirksamkeitserwartung hinsichtlich des Einsatzes von Experimenten im Geographieunterricht [Complexity-reduced practical experience in the GEO teaching-learning laboratory as a way of professionalising student teachers? A design-based research study on the development of self-efficacy expectations regarding the use of experiments in geography teaching]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 93–108). readbox unipress.

Rothland, M. (2020). Theorie-Praxis-Verhältnis in der Lehrerinnen- und Lehrerbildung [Theory-practice relationship in teacher education]. In C. Cramer, J. König, M. Rothland, & S. Blömeke (Eds.), *Handbuch Lehrerinnen- und Lehrerbildung* [Handbook on teacher education] (pp. 133–140). Klinkhardt.

Santagata, R., & Angelici, G. (2010). Studying the impact of the lesson analysis framework on preservice teachers' abilities to reflect on videos of classroom teaching. *Journal of Teacher Education, 61*(4), 339–349. https://doi.org/10.1177/0022487110369555

Santagata, R., & Guarino, J. (2011). Using video to teach future teachers to learn from teaching. *ZDM the International Journal on Mathematics Education, 43*(1), 133–145. https://doi.org/10.1007/s11858-010-0292-3

Scholl, D., & Plöger, W. (2020). Unterricht als Gegenstand der Lehrerinnen- und Lehrerbildung [Teaching as a subject of teacher education]. In C. Cramer, J. König, M. Rothland, & S. Blömeke (Eds.), *Handbuch Lehrerinnen- und Lehrerbildung* [Handbook on teacher education] (pp. 21–30). Klinkhardt.

Schuler, S., Rosenkränzer, F., Fanta, D., Hörsch, C., & Rieß, W. (2016). Das Professionswissen von Lehramtsstudierenden zur Förderung von systemischem Denken im Unterricht. Eine Interventionsstudie [Student teachers' professional knowledge to promote systemic thinking in the classroom: An intervention study]. In K.-H. Otto (Ed.), *Geographie und naturwissenschaftliche Bildung - der Beitrag des Faches für Schule, Lernlabor und Hochschule: Dokumentation des 21. HGD-Symposiums im März 2015 in Bochum* [Geography and science education—The subject's contribution to schools, learning labs and universities: Documentation of the 21st HGD Symposium in Bochum in March 2015] (pp. 172–187). readbox unipress.

Schwarz, H., Revilla, M., & Weber, W. (2020). Memory effects in repeated survey questions reviving the empirical investigation of the independent measurements. *Survey Research Methods, 14*(3), 325–344. https://doi.org/10.18148/srm/2020.v14i3.7579

Seidel, T., & Prenzel, M. (2007). Wie Lehrpersonen Unterricht wahrnehmen und einschätzen. Erfassung pädagogisch-psychologischer Kompetenzen bei Lehrpersonen mit Hilfe von Videosequenzen [How teachers perceive and assess teaching: Recording pedagogical-psychological competences of teachers with the help of video sequences]. *Zeitschrift Für Erziehungswissenschaft, Sonderheft, 8*, 201–218.

Seidel, T., & Stürmer, K. (2014). Modeling and measuring the structure of professional vision in preservice teachers. *American Educational Research Journal, 51*(4), 739–771. https://doi.org/10.3102/0002831214531321

Sherin, M. G. (2004). New perspectives on the role of video in teacher education. In J. E. Brophy (Ed.), *Using video in teacher education* (pp. 1–28). JAI Press.

Streitberger, S., & Ohl, U. (2020). Videobasierte Förderung der unterrichtsbezogenen Analysekompetenz. Problemaufriss, Forschungsansatz und erste Ergebnisse einer empirischen Studie mit angehenden Geographielehrkräften [Video-based promotion of classroom-based analytical competence: Problem outline, research approach and initial results of an empirical study with trainee geography teachers]. In M. Hemmer, A.-K. Lindau, C. Peter, M. Rawohl, & G. Schrüfer (Eds.), *Lehrerprofessionalität und Lehrerbildung im Fach Geographie im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 137–148). readbox unipress.

Streitberger, S., & Ohl, U. (2021). *Geographieunterricht planen, durchführen und analysieren* [Planning, teaching and analysing geography lessons]. UTB: In print.

Streitberger, S., Haltenberger, M., & Ohl, U. (2021). Empirical intervention study compass for subject-specific education research. URN: https://nbn-resolving.org/urn:nbn:de:bvb:384-opus4-861866. Accessed 29 Apr 2021.

Sweller, J., van Merrienboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251–296.

Taras, M. (2005). Assessment. Summative and formative: Some theoretical reflections. *British Journal of Educational Studies, 53*(4), 466–478.

Tashakkori, A., & Creswell, J. W. (2007). Editorial: The new era of mixed methods. *Journal of Mixed Methods Research, 1*(1), 3–7. https://doi.org/10.1177/2345678906293042

Theyßen, H. (2014). Methodik von Vergleichsstudien zur Wirkung von Unterrichtsmedien [Methodology of comparative studies on the impact of educational media]. In D. Krüger, I. Parchmann, & H. Schecker (Eds.), *Methoden in der naturwissenschaftsdidaktischen Forschung* [Methods in science didactics research] (pp. 67–79). Springer Spektrum.

Thiersch, S. (2020). Qualitative Längsschnittforschung. Eine Einleitung [Qualitative longitudinal research: An introduction]. In S. Thiersch (Ed.), *Qualitative Längsschnittforschung. Bestimmungen, Forschungspraxis und Reflexionen* [Qualitative longitudinal research: Definitions, research practice and reflections] (pp. 9–27). Budrich.

Vogt, M., & Scholz, J. (2020). Entwicklung und Struktur der Lehrerinnen- und Lehrerbildung in Deutschland [Development and structure of teacher education in Germany]. In C. Cramer, J. König, M. Rothland, & S. Blömeke (Eds.), *Handbuch Lehrerinnen- und Lehrerbildung* [Handbook on teacher education] (pp. 217–226). Klinkhardt.

von Roux, Y. (2020). GIS-Tools im Geographieunterricht. Entwicklung und Evaluation von GIS-Bildungsangeboten für Studierende und Geographielehrkräfte [GIS tools in geography teaching: Development and evaluation of GIS educational offers for students and geography teachers]. In M. Hemmer, A.-K. Lindau, C. Peter, & G. Schrüfer (Eds.), *„Auf den/die Geographielehrer/in kommt es an!?" – Lehrerprofessionalität und Lehrerbildung im Fokus von Theorie, Empirie und Praxis* ["It's the geography teacher who counts!?"—Teacher professionalism and teacher education in the focus of theory, empiricism and practice] (pp. 207–222). readbox unipress.

Walford, R. (1996). 'What is geography?" An analysis of definitions provided by prospective teachers of the subject. *International Research in Geographical and Environmental Education, 5*, 69–76. https://doi.org/10.1080/10382046.1996.9964991

Wilhelm, T., & Hopf, M. (2014). Design-Forschung [Design research]. In D. Krüger, I. Parchmann, & H. Schecker (Eds.), *Methoden in der naturwissenschaftsdidaktischen Forschung* [Methods in science didactics research] (pp. 31–42). Springer Spektrum.

Witzel, A. (2020). Qualitative Längsschnittstudien [Qualitative longitudinal studies]. In G. Mey, & K. Mruck (Eds.), *Handbuch Qualitative Forschung in der Psychologie* [Handbook on qualitative research in psychology] (pp. 59–77). Springer. https://doi.org/10.1007/978-3-658-26887-9_27

Yin, R. K. (2016). *Qualitative research from start to finish*. The Guilford Press.

Yoon, K. S., Duncan, T., Lee, S. W.-Y., Scarloss, B., & Shapley, K. L. (2007). *Reviewing the evidence on how teacher professional development affects student achievement*. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southwest.