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Designing Research in Subject Matter Didactics. Results and Open Questions of a Delphi Study

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Abstract

Up to now, the discussion about research designs in subject-matter didactics has mainly taken place within the disciplines of this academic field. A generic model is useful in order to stimulate a discussion across different disciplines as it provides a common reference point. Such a model was the goal of a Delphi study, which consisted of two rounds. This paper describes the basic results of this Delphi study. On the one hand it brought about the basic contours of such a model: it is characterized by three basic dimensions (subject areas, methodologies, reference theories) and categories by which these three dimensions were operationalized. On the other hand, the Delphi brought about those topics that need to be discussed in future. This is especially true for categories on the dimensions of methodologies and reference theories. In summary, this study offers arguments and impulses for further discussion about the understanding of research in subject-matter didactics.

Keywords

Research Design – Subject-Matter Didactics – Delphi Study – Methodology – Objects of Inquiry – Theories of Reference

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The transfer of knowledge between the various disciplines of subject-matter didactics relies on shared concepts and research designs. Most of the discourse on what research in subject-matter didactics should concern itself with, however, takes place in an insular fashion within the individual disciplines of this academic field. Yet, there are some attempts to stimulate cross-disciplinary discussion regarding an overarching theory of subject-matter didactics (Bayrhuber et al., 2012; Rothgangel, 2020). Publications on research designs in subject didactics also make a contribution to the understanding of research in subject didactics (Bayrhuber, 2011; GFD 2015). Nonetheless, these initiatives have not yet led to a shared understanding of research designs across the disciplines of subject-matter didactics. The transfer of knowledge and expertise between these disciplines is still impeded by a cacophony of voices within the academic discourse. In order to focus this discourse, a generic model of research designs is needed, as it provides a common reference point for research designs of the different subject didactics. Such a model was the goal of a Delphi study of two rounds. It brought about the basic contours of such a model and identified the issues that are still to be discussed in future. This paper describes the basic results of this Delphi study. Therefore, in the following, we first briefly describe the generic model of subject didactic research designs (1), then delineate the method of the Delphi study (2) as well as the central findings thereof (3).[1] The article is concluded by a discussion of these findings (4). Since this Delphi took place in Germany, the paper will address the German discourse.

1 Introduction

It was the German "Gesellschaft für Fachdidaktik" which stimulated a discussion regarding designs of subject-matter didactic research. After a conference on this topic in 2011 and its publication (Bayrhuber et al., 2012), the question of the designs of subject-matter didactic research was continued in a GFD working group, whose efforts resulted in a GFD statement (GFD 2015). This process was, first of all, stimulated by higher education policy, namely the fact that subject-matter didactic third-party funding proposals have been reviewed primarily by scholars from pedagogical-psychology or the relevant subject-specific academic discipline. In consequence, some one-sided methodological or subject-specific assessments were criticized as well as the lack of subject-matter didactic expertise in several reviews. In order to appropriately evaluate applications for external funding in the field of subject-matter didactics, an understanding of specific designs of subject-matter didactic research appears necessary.

Building on the GFD-initiative, this need has been addressed by a Delphi study with the goal to both reconstruct and justify the particularity of subject-matter didactic research. It took into account both the commonalities of and the differences between the various disciplines in this academic field. The core of this Delphi study is a generic model of

[1] We would like to thank the scholars who participated in the first round of the Delphi. The large response encourages us to continue on the path we have chosen. Please note, that the answers on particular research designs which also have been assessed in the first round of this Delphi will be analysed elsewhere so as not to overload this paper.

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subject-matter didactic research which should enable a description of relevant research designs. The purpose of this approach can be seen in the fact that its results can be used or exploited in various ways: A generic model of designs of subject-matter didactic research potentially offers 1) a basis for interdisciplinary discussion amongst the various subject-matter didactics and between the subject-matter didactics and other sciences, 2) a classification of one's own subject-matter didactic research within this model, 3) a training in the theory of science for junior researchers in the subject-matter didactics, 4) an understanding of the diversity of other subject-matter didactics and, at the same time, fruitful learning opportunities arising from increased interactio among subject-matter didactics, and 5) a justification of the subject-matter didactics in terms of the theory of science, which goes beyond the focus on individual subject-matter didactics.

In the German discourse on subject-matter didactics such a generic model still is lacking. Many handbooks and introductions fail to mention research at all (e. g. biology: Berck & Graf, 2018; German language and literature: Grießhaber et al., 2018; Steinig & Huneke, 2022; English language: Klippel & Doff, 2015; French language: Nieweler et al., 2017; mathematics: Fuchs & Landerer, 2021; music: Ernst, 2013; philosophy: Pfister et al., 2016; physics: Mikelskis & Berger, 2010; politics: Reinhardt, 2018; religion: Woppowa, 2018). If there is a chapter or section on research, it primarily deals with research methods and often exclusively with empirical approaches to the field (e. g. Beutel et al., 2022; Lange & Reinhardt, 2007; Memminger, 2021; Nida-Rümelin et al., 2015). Few volumes describe more than just empirical methods. In the "Handbuch Sachunterricht" "historic" and "pragmatic" methods (Kahlert et al., 2015) are mentioned. The "Einführung in die Sportpädagogik" lists the three forms of research in sports education: a theoretical-conceptual, an empirical-analytic and a normative one (Krüger, 2019). Finally, few volumes and articles offer more comprehensive descriptions of subject-matter didactic research designs that do not focus exclusively on methodological aspects (e. g. Leuders, 2015; Petrik, 2016; Rolle, 2012; Schecker et al., 2014; Wiesemann & Wille, 2014). The "Handbuch Mathematikdidaktik" even has an elaborate section on research, distinguishing between research objects and goals (Vollstedt et al., 2015), qualitative methods (Schreiber et al., 2015), quantitative methods (Krauss et al., 2015) and theory building (Prediger, 2015). These texts, however, do not adopt the meta-perspective of what defines the presented research designs.

Against this background, the GFD offers a first comprehensive account on what could be a research design in subject-specific didactics by defining it as the "totality of all content-related, methodological and organizational aspects of research that can be described in the planning, implementation, evaluation and processing of the results of a subject didactic research project [...]. These include, among other things, the theoretical relevance, the interest in knowledge, the methods of investigation and evaluation, and the procedures for using the findings obtained." (GFD 2015: 2) This understanding of research design clearly goes beyond given applications of this term that predominantly associate it with the methodological aspect of research in the general discourse on research designs (e. g. Creswell & Creswell, 2018; DeForge, 2010; Gorard, 2013). In religious education, Rothgangel and Riegel adopted the GFD-definition to reevaluate the methodological discourse of this particular subject-matter didactic discipline. They

DOI: https://doi.org/10.23770/rt1855

created a three-dimensional model of relevant research which is characterized by three basic dimensions (Riegel & Rothgangel, 2020):

i. the subject area that is studied in the projects of this design,

ii. the theories of reference in light of which this subject area is reflected, and

iii. the methodology by which this subject area is studied (see. Fig. 1).

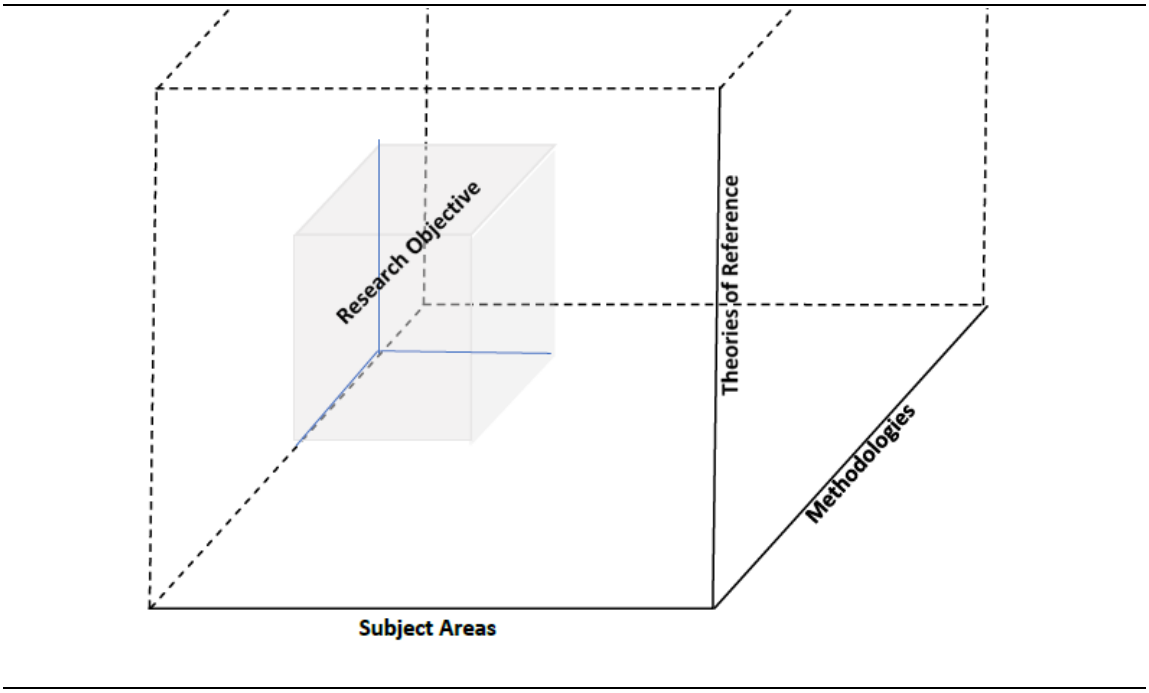

Fig. 1 Generic Model of Research Designs in Subject-Matter Didactics

The model assumes that each research design in the field of subject-matter didactics can be located within the space created by the three dimensions of subject area, theory of reference and methodology. According to this view, a didactic research design is characterized by the unique interplay of research objects, reference theories, and methodological approaches, which is common to the projects that can be assigned to this design. The expression of this interplay is determined by the research objective. The research objective specifies how the projects within a research design relate to the three basic dimensions of subject area, reference theory, and methodology. The research objective, therefore, is a functional equivalent of the research question at the level of individual research projects and the epistemological interest at the level of academic disciplines (Riegel & Rothgangel, 2021b).

The general layout of the model corresponds to the discourse within the philosophy of science (Balzer, 2009; Godfrey-Smith, 2003; Gutting, 2005; Schurz, 2014). The special character of subject-matter didactics becomes clear as soon as one operationalizes the three basic dimensions. To operationalize the methodological dimension, a distinction coined by Schröder was used. He describes the five categories of historical methods as systematic-hermeneutic, comparative, empirical, and practice-oriented (Schröder,

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2012, p. 274). This distinction is widely recognized in religious education and also applies to methodologies that may be relevant beyond the borders of the discipline. The categories that operationalize the dimension of characteristic subject areas have been retrieved by a comparative analysis of self-reports submitted by 17 subject-matter didactics (Rothgangel, 2020) and the analysis of basic publication in religious education (Riegel&Rothgangel 2020). According to these analyses, research in this academic field typically addresses the subject areas of learning content, teaching and learning processes, teachers, students, subject specific learning as school subject and its contexts, and theories of subject-matter didactics. Finally, research is driven by the theories that frame the process of discovery and justification. In the case of subject-matter didactic research, Riegel and Rothgangel propose the following disciplines from which such theories originate: the relevant academic subject-matter discipline, educational sciences, psychology, sociology, cultural studies, and philosophy (Riegel & Rothgangel 2021b: 5-6).

This generic model of research designs in subject-matter didactics has been widely approved within the discipline of religious education (Riegel & Rothgangel, 2022). An inter-disciplinary discussion on such designs underpinning the various disciplines of subject-matter didactics, however, hast just started (e. g. Rothgangel, 2020). As previously seen, the relevant discourse on designs is predominantly driven by methodological issues. This brings about the first research question, that deals with the suitability of the general model as such:

> *RQ1: Do the dimensions of the model and their operationalizations offer an appropriate framework to describe research designs in subject-matter didactics?*

In addition, the operationalization of each of the three basic dimensions of the model needs further exploration. The previously mentioned categories that operationalize the dimensions of methodologies, subject areas, and reference theories have been formulated in the context of religious education. This particular discipline of subject-matter didactics, however, is far from representative of the entire field of subject-matter research. Therefore, the second research question addresses the appropriateness of the categories according to which the three basic dimensions of the general model have been operationalized.

> *RQ2: Do the categories by which the three dimensions of methodologies, subject areas, and reference theories have been operationalized cover the relevant spectrum of methodologies, subject areas, and reference theories in the relevant discipline of subject-matter didactics?*

2 Method

These research questions have been answered within two rounds of a Delphi study. A Delphi study is a tried and tested means of obtaining the expertise in a given field and is increasingly being used in educational science (Gorghiu et al., 2013; Kunina-Habenicht et al., 2012; Zawacki-Richter, 2009) and subject didactics (Burkard & Schecker, 2014; Hermanns & Keller, 2021). Delphi studies address experts in the field under investigation

DOI: https://doi.org/10.23770/rt1855

and leverage and condense their expertise (Crawford & Wright, 2014; Häder, 2014; Niederberger & Renn, 2019; Okoli & Pawlowski, 2004). Usually, these studies take place over several rounds, with the results of each round being fed back to the anonymous interviewees so that these individuals can align their perspective on the issue under study with these results in the following Delphi round (Cuhls, 2019, pp. 5–9). Most often, Delphi studies begin with strongly qualitative sections to clarify the broad contours of the field under study. To the extent that these contours become sharper, quantitative segments are then added in subsequent rounds. Beyond these basic characteristics, there is still no consensus on the concrete implementation of Delphi studies (Häder, 2014, pp. 19–27).

In the present case, the first round took the form of an online questionnaire containing both quantitative and qualitative questions. This round is based on the previously described analysis of Riegel and Rothgangel, namely the discussion within religious education (Theo-Web 19/1, 2020) and the analysis of the self-portrayals of 17 subject-matter didactics (Rothgangel, 2020). The questionnaire comprised three sections. The first was about the architecture of the generic model, the second on the operationalization of its three basic dimensions, and the third about possible research formats in subject-matter didactic research. At the end of the first round's questionnaire the participants could leave their mail-address if they wished to participate in the second round. 132 scholars did so. They were informed of the results of the first round in written form and invited to respond to the questionnaire of the second round. This second questionnaire addressed those aspects of the first round in which unanimity had not yet been reached. This second questionnaire, again, was administered online and exclusively included qualitative questions.

The questionnaire of the first round was first offered to the scholars of religious education (5 May to 1 July 2021), then to the scholars of the other disciplines of subject-matter didactics (1 September to 31 October 2021). This two-step procedure was due to organizational challenges, since the invitation to participate in the survey was administered via the professional society of each discipline of subject-matter didactics. All in all, N_1 = 305 scholars filled in the questionnaire (see table 1). Of the 132 partcipants who agreed to be interviewed again in the first round of the Delphi, N_2 = 68 took this chance. The relevant questionnaire remained available online through April and May 2022. Since we did not assess any personal information due to the Delphi's claim for anonymity, no further information on the second round's sample can be given. However, it is a true subset of the first round's sample.

DOI: https://doi.org/10.23770/rt1855

Tab. 1 Structure of the Sample of the Delphi's First Round

	Participants		Academic Position			Research Expertise		
			Prof.	*Post-Doc*	*else*	*< 5*	*5-15*	*> 15*
Disciplines	*n*	*%*	*n*	*n*	*n*	*n*	*n*	*n*
Arts	6	2.0	3	1	1	0	5	0
Biology	14	4.6	5	5	2	2	5	5
Care & Health	3	1.0	2	0	1	1	1	1
Chemistry	14	4.6	5	5	1	2	5	4
Computing	2	0.7	1	0	0	0	0	1
Economy	7	2.3	5	0	0	0	2	3
Foreign Languages	15	4.9	5	4	3	0	9	3
Geography	5	1.6	1	2	0	0	2	1
German Language	32	10.5	18	6	1	2	17	6
History	9	3.0	4	4	0	0	5	3
Latin & Greek	2	0.7	1	0	1	0	0	2
Mathematics	39	12.8	14	9	4	2	16	9
Music	11	3.6	9	0	1	0	5	5
Nature & Culture	15	4.9	5	7	2	2	8	4
Nutrition and Home Economic	8	2.7	5	0	0	1	2	2
Philosophy	14	4.6	5	6	0	3	7	1
Physics	9	3.0	4	3	0	0	4	3
Politics & Social Sciences	16	5.2	11	1	0	2	4	6
Religion	75	24.6	*	*	*	*	*	*
Sports	1	0.3	0	1	0	0	1	0
Technique	8	2.6	4	4	0	2	2	4
Total	305	100,0	107	58	17	19	100	63

Note: * has not been assessed

Analysis of the quantitative data utilized descriptive statistics and one-way analysis of variance. In consequence, the Likert scales were treated as metric scales (Winter & Dodou, 2010). Using descriptive statistics we assess the average relevance of the single categories on the entire sample, ANOVA is used to gain insights into discipline-specific differences. Due to the sizes of the sub-samples, ANOVA will only be run on the sub-samples of religious education (n = 75), mathematics (n = 39) and German language (n = 32). All other sub-samples count less than 30 participants which might distort the statistical analysis (Bortz, 2005, p. 287). All statistical calculations will be carried out with the software package SPSS 27. Analysis of the qualitative data was conducted using Grounded Theory (Glaser & Strauss, 1996; Hermisson & Rothgangel, 2018). The two general techniques that form the basis for

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the coding strategies used in Grounded Theory are constant comparison and asking questions (Strauss & Corbin 1996, p. 44). Of the three basic coding methods – open coding, axial coding, and selective or theoretical coding (Strauss & Corbin, 1996, p. 40) – which are often mixed in practice, open coding was used primarily in this analysis.

3 Results

The research questions address the plausibility of the general model itself (RQ1) as well as the relevance of the operationalization of the three basic dimensions of this described model (RQ2). The report of the empirical results will be structured according to these two questions.

3.1 The Plausibility of the General Model

The plausibility of the general model itself has been assessed in the first round by two items with closed-ended answer format and two relevant open-ended questions. The means of the two items indicate a general plausibility of the general model (see tab. 2).

Tab. 2 Assessment of the General Model: Means and Standard Deviations

	n	*M*	*SD*
Assessment of Methodologies, Subject Areas, and Reference Theories	263	4.39	1.11
Assessment of Research Objective	268	4.76	1.27

Note. 1 = none at all appropriate; 2 not appropriate; 3 = rather not appropriate; 4 = rather appropriate; 5 = appropriate; 6 = very appropriate

Checking this result by the influence of particular disciplines of subject-matter didactics does not change the general picture (see. tab. 3). On the one hand, scholars of Mathematics indicate a higher need for clarification than those of Religious Education and German Language. But all these means are within the range, which indicates some appropriateness of the model. Furthermore, the three examples do not cause any significant differences if the plausibility of the research objective is regarded.

Tab. 3 Influence of Subject Didactics on the Assessment of the General Model: ANOVA with Games-Howell Post-Hoc-Test

	Religious Education			Mathematics			German Language		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Methodologies, Subject Areas, and Reference Theories	71	4.63_a	1.09	30	3.97_b	1.03	28	4.57_a	0.79
Research Objective	67	4.55	1.12	32	4.78	1.26	29	4.72	1.33

Notes: In a one-way analysis of variance (ANOVA) using the Games-Howell post-hoc procedure, the mean values of a row that share the same subscript form a subgroup that differs to a .05 level of significance from the mean values that have a different subscript.

1 = none at all; 2 = a modest one; 3 = a rather modest one; 4 = a rather big one; 5 = a big one; 6 = a very big one

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This general approval was expressed in the answers to the open-ended questions, too. The model has been appreciated e.g., as “plausible” (146; 447), “interesting” (442), and “good, important idea” (115). More closely, positive evaluations are motivated, on the one hand, by the model itself (e.g., “good degree of abstraction,” 183; “appropriate dynamics of the model with influence of the three components,” 160) and, on the other hand, the positive functions of the model are emphasized (e.g., “helpful orientation,” 272; “dimensions allow systematic access to subject didactic research,” 196).

There were also some critical comments. First, it was noted, for example, that the model is “too rigid” (RD 112), “too general” (17, 43, 262), and that “its purpose is not clear” (43, 297, 315). Such comments refer to the communication of the model’s purpose, which clearly has to be improved. A second equally noteworthy remark is that only external theories of reference are addressed with the model and that it should be supplemented by internal theories of reference of subject matter didactics (33, 34). In this sense, it has been noted that subject matter didactics have their own theories and methodologies (413, 432). In consequence, a relevant category should be added to the operationalization of basic dimension of theories of reference. 3) Third, it is stated that the category of research objective is conceptually unclear (221; cf. 110), especially since it appears in the diagram as part of the research format (23, 317, 336). These comments of the Delphi’s first round have been further elaborated in the Delphi’s second round. Here it became clear that the precise locus of that research objective can neither be within one of the model’s basic dimensions nor be identical with the design itself. As the design’s coordinating agency, it has to be located in between the basic dimensions. Moreover, the participants suggested that the research objective defines whether a design is related to basic research or applied research in subject-matter didactics.

3.2 The Operationalization of the Three Basic Dimensions

The second research question addresses the operationalization of the methodologies, the subject areas and the reference theories. Their appropriateness has been checked by closed-ended questions. The understanding of the labels was assessed by open-ended questions.

3.2.1 Methodologies

Regarding the general relevance of the methodological categories, descriptive statistics indicate that practice-oriented approaches are used in research in subject-matter didactics as well as empirical ones (see tab. 4). The mean of systematic-hermeneutical approaches in research is still positive but significantly lower than that of already mentioned approaches. A rather modest relevance has been attributed to historical and comparative approaches. This picture changes slightly when the relevance of these approaches for future research is assessed (see tab. 4). Four out of the five options are regarded as important. It is only the historical approach that still is seen of minor relevance. Note that eight out of ten standard deviations are quite high indicating that there is a great variance within the relevance of these categories.

DOI: https://doi.org/10.23770/rt1855

Tab. 4 Assessment of the Methodologies: Means and Standard Deviations

	Relevance for Own Research			Relevance for Future Research		
Methodologies	*N*	*M*	*SD*	*n*	*M*	*SD*
Historic	290	2.63_a	1.57	281	3.58_a	1.40
Systematic-Hermeneutical	281	3.72_b	1.73	271	4.42_b	1.39
Compararative	257	3.01_a	1.46	252	4.17_b	1.34
Empirical	301	4.86_c	1.48	298	5.43_c	0.95
Practice-Oriented	297	4.91_c	1.22	292	5.41_c	0.85

Notes: In a one-way analysis of variance (ANOVA) using the Games-Howell post-hoc procedure, the mean values of a column that share the same subscript form a subgroup that differs to a .05 level of significance from the mean values that have a different subscript.

1 = none at all; 2 = a modest one; 3 = a rather modest one; 4 = a rather big one; 5 = a big one; 6 = a very big one

Regarding methodological differences between particular disciplines of subject-matter didactics, practice-oriented and empirical methodologies seem to be the common ground of research in Religious Education, Mathematics and German Language (see tab. 5). There are no significant differences in the relevance of both own research and future research. Regarding historical, systematic-hermeneutical, and comparative approaches, Religious Education and Mathematics represent two different domains of research. While all three methodologies are of hardly any relevance in Mathematics, systematic-hermeneutical research is crucial in Religious Education and historic and comparative research get some modest attention. Research in German Language is more similar to that in Religious Education than that in Mathematics.

Tab. 5 Influence of Subject Didactics on the Assessment of the Methodologies: ANOVA with Games-Howell Post-Hoc-Test

	Religious Education			Mathematics			German Language		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Own Research									
Historic	74	3.12_a	1.39	36	1.86_b	1.44	28	2.36	1.42
Systematic-Hermeneutical	74	4.73_a	1.14	30	2.37_c	1.30	30	3.90_b	1.90
Compararative	68	3.38_a	1.33	27	2.44_b	1.37	28	3.07	1.49
Empirical	74	4.42	1.66	38	5.26	1.37	31	4.77	1.65
Practice-Oriented	75	4.81	1.24	37	4.73	1.39	31	5.03	1.20
Future Research									
Historic	73	4.25_a	1.05	31	2.74_c	1.24	28	3.50_b	1.58
Systematic-Hermeneutical	72	5.18_a	0.85	24	3.21_b	1.35	29	4.55_a	1.24

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Compararative	67	4.64_a	1.10	25	3.56_b	1.29	28	4.21	1.42
Empirical	75	5.28	1.10	37	5.49	0.96	30	5.40	1.10
Practice-Oriented	71	5.48	0.79	37	5.30	0.85	30	5.50	0.86

Notes: In a one-way analysis of variance (ANOVA) using the Games-Howell post-hoc procedure, the mean values of a row that share the same subscript form a subgroup that differs to a .05 level of significance from the mean values that have a different subscript.

1 = none at all; 2 = a modest one; 3 = a rather modest one; 4 = a rather big one; 5 = a big one; 6 = a very big one

According to the answers to the open-ended item, which refers to the methodologies, the analysis with Grounded Theory shows that several aspects are in need of clarification. First, there are a number of suggestions to add further categories to the dimension of methodologies. Most suggestions addressed methodologies which could be regarded as associated with philosophy, such as phenomenological (RD 89, 129), constructivist (RD 150), philosophical-analytical (447), discourse-analytical (449), and ideology-critical (RD 101, 150, 153). These suggestions, however, rather differentiate the suggested categories than add new ones. Second, several participants expressed some ambiguity in their understanding of the categories “comparative” and "practice-oriented" (21, 33, 34, 43, 197, 443). The particular findings in the Delphi’s second round showed that comparative research is defined by a specific subject area, such as different countries or different historic eras, rather than by a particular methodology. Then, most participants argued that all research in subject-matter didactics is practice-oriented. Therefore, it cannot represent a particular methodological category. Third, a certain dominance of "empirical methodologies" is visible insofar as the division into quantitative and qualitative methods is suggested (8, RD 172). Here, the Delphi’s second round confirmed this suggestion, although it became obvious that that distinction seems to be more common in the MINT disciplines than in those disciplines from the arena of humanities and linguistics. Fourth, the category of “systematic-hermeneutical” caused some irritation among certain participants. On the one hand, predominantly scholars with a background in MINT asked whether this category is related to qualitative research (2, 33, 253). On the other hand, participants with a background in humanities expressed that there are various hermeneutical options in their discipline. Therefore, the term "hermeneutic" is retained as a relevant methodology in several subject didactics. In consequence of these four feedbacks, the generic model will contain four categories on its methodological dimension, namely historical – hermeneutic – qualitative-empirical – quantitative-empirical. In addition, other methodologies such as "phenomenological" were also mentioned in the second round. These are not listed specifically, because in general hardly any complementary proposals were made. However, the symbol "(...)" indicates that the explicitly mentioned methodologies are by no means a closed list (see below Figure 2). Finally, combining quantitative and qualitative empirical approaches allows for mixed-methods.

3.2.2 Subject Areas

Concerning the subject areas of research the quantitative data show a broad consensus that subject-matter didactic research concerns itself with teaching and learning processes, students, learning content and with the subject in which teaching and

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learning takes place (see tab. 6). Also, research on teachers and theories of subject specific learning are regarded as relevant areas in one's own research, even if this relevance is significantly smaller than that of research on teaching and learning processes. All means rise when future research is regarded (see tab. 6). Although there are significant differences in the estimation of this relevance, all offered subject areas are regarded as very important. The generally high standard deviations regarding the relevance of those areas in own research could have been expected since the participants' expertise is on various subjects. The small standard deviations of the assessment of future research show that the community is fairly homogeneous in this regard.

Tab. 6 Assessment of the Subject Areas: Means and Standard Deviations

Subject Areas	Relevance for Own Research			Relevance for Future Research		
	n	*M*	*SD*	*n*	*M*	*SD*
Learning Content	299	4.89	1,13	298	$5{,}30_b$	0,92
Teaching and Learning Processes	301	5.21_b	1,01	300	$5{,}61_c$	0,67
Teachers	303	4.51_a	1,30	299	$5{,}30_b$	0,89
Students	302	4,91	1,16	299	5,54	0,73
subject specific learning as school subject and its contexts	296	4,64	1,26	297	$5{,}02_a$	1,07
theories of subject-matter didactics	299	$4{,}39_a$	1,35	297	$4{,}80_a$	1,23

Notes: In a one-way analysis of variance (ANOVA) using the Games-Howell post-hoc procedure, the mean values of a column that share the same subscript form a subgroup that differs to a .05 level of significance from the mean values that have a different subscript.

1 = none at all; 2 = a modest one; 3 = a rather modest one; 4 = a rather big one; 5 = a big one; 6 = a very big one

There are just two significant differences in the assessment of these areas regarding select disciplines of subject-matter didactics (see. tab. 7). First, the analysis of the processes of teaching and learning are significantly more often applied in German Language than in Religious Education. Second, research on the character of the school subject is regarded as significantly more important in Religious Education than in Mathematics. All other assessments do not differ significantly between the three exemplars of subject-matter didactics. Moreover, the standard deviations do not indicate that there is much variance in this assessment.

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Tab. 7 Influence of Subject Didactics on the Assessment of the Subject Areas: ANOVA with Games-Howell Post-Hoc-Test

Subject Areas	Religious Education			Mathematics			German Language		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Own Research									
Learning Content	73	4.78	1.24	39	5.00	1.10	30	5.07	0.94
Teaching and Learning Processes	75	4.92_a	1.21	39	5.31	0.95	30	5.50_b	0.73
Teachers	75	4.63	1.27	39	4.51	1.47	31	4.35	1.38
Students	74	4.91	1.11	39	4.77	1.60	31	5.03	0.91
subject specific learning as school subject and its contexts	74	4.58	1.35	34	4.35	1.30	31	4.55	1.18
theories of subject-matter didactics	75	4.21	1.20	38	4.26	1.45	30	4.63	1.38
Future Research									
Learning Content	73	5.44	0.87	39	5.10	1.02	30	5.53	0.57
Teaching and Learning Processes	74	5.58	0.66	39	5.59	0.72	31	5.81	0.40
Teachers	73	5.41	0.83	39	5.23	1.01	31	5.03	0.91
Students	73	5.64	0.56	39	5.44	0.82	31	5.52	0.77
subject specific learning as school subject and its contexts	74	5.27_a	0.88	35	4.69_b	1.21	31	4.77	1.15
theories of subject-matter didactics	74	4.77	1.20	37	4.43	1.39	29	5.03	1.05

Notes: In a one-way analysis of variance (ANOVA) using the Games-Howell post-hoc procedure, the mean values of a row that share the same subscript form a subgroup that differs to a .05 level of significance from the mean values that have a different subscript.

1 = none at all; 2 = a modest one; 3 = a rather modest one; 4 = a rather big one; 5 = a big one; 6 = a very big one

In the feedback to the open-ended question on the subject areas, certain ambiguities are addressed, suggestions for changes are made, and supplementary suggestions are provided. Basically, it can be noted that such categories cannot be formulated with some overlap to other categories. Instead of representing clearly distinguishable objects of research, such categories point to the main focus of the relevant subject area. Having this in mind, the participants' comments brought about the need to clarify some of the categories. First, the category "theories of subject-matter didactics" seems to be misunderstood by or unclear to some scholars (305, 328). What is meant here is the scientific-theoretical reflection in subject-matter didactics, since in this case the "theories of subject-matter didactics" are the subject of subject-matter didactic research. This should be clearly stated in the future. Second, it is plausible to suggest that groups of

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people beyond teachers and students, such as students (70, 82, 111), adults (111, 315), and school administrators (113), can also be a subject of subject didactic research. Therefore, in the future, the questionnaire will not identify teachers and students as the subject area, but rather teachers and learners more globally. Third, supplementary suggestions such as curricula and curricular learning objects (223, 281), artifacts and learning materials (217, 315) seemed to be worthy of consideration for amending the list of categories. In this regard, the comments in the Delphi's second round offered good arguments to add the categories of "methods" and "media" on this dimension, since, among other things, corresponding research exists in subject didactics. However, it should be kept in mind that the subject areas can only be formulated with limited separability, because when one subject area is named, other areas are often associated with it.

3.2.3 Reference Theories

From among the reference theories offered, the relevant academic subject-matter discipline and educational sciences are seen as very relevant for one's own research (see. tab. 8). Psychology and the other disciplines of subject-matter didactics are still considered relevant but to a lesser degree. A very modest relevance in one's own research is ascribed to cultural studies and philosophy. Again, the high standard deviations indicate the large variety of the relevance of those reference theories to one's own research. Nonetheless, all these categories are assessed as at least quite relevant in regard of future research (see tab. 8). Still, cultural studies and philosophy are seen as significantly less relevant than psychology, and psychology is seen as less relevant than the academic subject-matter discipline. But all means are clearly in the section of the answer spectrum that indicates relevance. Again however, the high standard deviations show that these assessments vary between the participants.

Tab. 8 Assessment of the Reference Theories: Means and Standard Deviations

	Relevance for Own Research			Relevance for Future Research		
Reference Theories	*n*	*M*	*SD*	*n*	*M*	*SD*
Academic Subject-Matter Discipline	301	4.94_c	1.15	303	5.22_c	1.01
Educational Sciences	300	4.67_c	1.20	300	5.05	1.06
Psychology	299	4.12_b	1.32	300	4.80_b	1.17
Sociology	301	3.58	1.42	295	4.27	1.35
Cultural Studies	296	3.27_a	1.53	293	4.01_a	1.51
Philosophy	297	3.06_a	1.53	294	3.79_a	1.47
Other Disciplines of Subject-Matter Didactics*	226	3.96_b	1.24	223	4.73_b	1.08

Notes: In a one-way analysis of variance (ANOVA) using the Games-Howell post-hoc procedure, the mean values of a column that share the same subscript form a subgroup that differs to a .05 level of significance from the mean values that have a different subscript.

1 = none at all; 2 = a modest one; 3 = a rather modest one; 4 = a rather big one; 5 = a big one; 6 = a very big one

* This item has not been assessed on the sub-sample of religious education.

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There are no significant differences in the assessment of the relevance of both academic subject-matter disciplines and educational sciences either for one's own research nor for future research if the focus is on Religious Education, Mathematics and German Language (see tab. 9). These three disciplines also agree on the relevance of psychology in own research. In all other aspects it is always the scholars of Religious Education who ascribe the highest relevance to the categories: in one instance they do so together with the scholars from Mathematics (psychology in future research), in another they are accompanied by the scholars of German Language (cultural studies in own research). In the other cases the participants in Mathematics and German Language regard these reference theories as significantly less relevant than the scholars of Religious Education.

Tab.9 Influence of Subject Didactics on the Assessment of the Reference Theories: ANOVA with Games-Howell Post-Hoc-Test

	Religious Education			Mathematics			German Language		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Own Research									
Academic Subject-Matter Discipline	75	5.15	1.02	38	4.68	1.19	31	5.13	0.99
Educational Sciences	75	5.00	1.04	35	4.43	1.38	31	4.74	1.06
Psychology	73	4.22	1.15	38	4.61	1.22	30	3.97	1.16
Sociology	75	4.40_a	1.09	38	2.58_b	1.20	31	3.13_b	1.28
Cultural Studies	73	4.08_a	1.37	36	2.08_b	1.05	31	3.52_a	1.56
Philosophy	75	3.63_a	1.39	36	2.39_b	0.99	31	2.42_b	1.50
Future Research									
Academic Subject-Matter Discipline	75	5.45	0.89	38	4.97	1.03	31	5.35	0.95
Educational Sciences	73	5.37	0.92	38	5.00	0.96	31	5.19	0.70
Psychology	74	5.07_a	0.80	38	5.13_a	0.88	31	4.58_b	1.06
Sociology	73	5.07_a	0.89	36	3.53_b	1.32	31	3.81_b	1.17
Cultural Studies	73	4.90_a	0.95	34	2.88_b	1.37	31	4.06_c	1.48
Philosophy	74	4.57_a	1.10	34	2.94_b	1.21	31	2.97_b	1.45

Notes: In a one-way analysis of variance (ANOVA) using the Games-Howell post-hoc procedure, the mean values of a row that share the same subscript form a subgroup that differs to a .05 level of significance from the mean values that have a different subscript.

1 = none at all; 2 = a modest one; 3 = a rather modest one; 4 = a rather big one; 5 = a big one; 6 = a very big one

With regard to the answers to the open-ended item concerning theories of reference, it can be noted that the scholars agree in the importance of theories in research designs. There is also consensus that such theories are strongly related to the academic discipline in which they are formulated. Most of the disciplines by which the dimension of reference theories were operationalized have been approved by the participants with

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some minor specifications. For example, it is noted that there are subject matter didactics that refer to several academic subject-matter disciplines (18, 78). For this reason, the relevant category in the model was changed into "Academic Subject-Matter Discipline(s)". No unanimous result could be retrieved from both rounds of the Delphi whether the relevant pedagogical discipline should be called “Erziehungswissenschaft” or “Bildungswissenschaften”. Here a reflex of the relevant German discussion comes to light which cannot be solved by this Delphi either. In this area more discussion is needed.

4 Discussion

Overall, the generic model of subject-matter didactic research designs is widely approved of by the participants. Its three-dimensional structure seems to be plausible, most of the categories by which these dimensions have been operationalized refer to relevant aspects of research in the field of subject-matter didactics. Additionally, the differences in the relevance of many categories in the disciplines of German Language, Mathematics and Religious Education appear plausible against the various backgrounds of these disciplines. They give proof of the great variance of research in this academic field. The findings indicate that the model presented is valid in general. Together, this support across the various disciplines of subject-matter didactics and the general validity suggests that there is good reason to improve the model rather than to change it.

Regarding potential improvements some comments can be adopted straightaway. Suggestions of this kind resulted in the following changes in the model:

1) On the dimension of theories of reference, the category “Academic Subject-Matter Discipline” will be substituted by the category “Academic Subject-Matter Discipline(s)” to acknowledge the fact that some disciplines of subject-matter didactics refer to more than one academic subject-matter discipline.

2) Then, some of the scholars argued that the categories of the dimension “Reference Theories” rather represent disciplines than theories. Understanding a discipline as the primary unit of the inner differentiation of science (Stichweh 2013, 17), this corresponds to the conceptual idea of this dimension. Consequently, the title of this dimension changes into "Disciplines of Reference".

3) On the dimension of methodologies, the new categorization will comprise the four options of “historical”, “quantitative-empirical”, “qualitative-empirical” and “hermeneutic”. The categories “comparative” and “practice-oriented” will be skipped.

4) To cover the broad spectrum of learners that are addressed within research in subject-matter didactics, the relevant category on the dimension of subject areas will be changed from “Students” into “Learners”.

5) The category of “the school subject and its contexts” has been regarded as too particular by some participants since some disciplines of subject-matter didactics also analyze processes of teaching and learning outside the school context. Therefore, the revised label of this category is “Places of Subject-Matter Learning and their Contexts”.

6) Some of the scholars have been puzzled by the arrowheads in which every dimension ended in the figure of the model. According to these comments the arrowheads indicate

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a metric dimension, while the categories by which the dimensions have been operationalized do not even indicate some ordinal order. Therefore, the arrowheads have been deleted from the figure and a category "(…)" has been added on each dimension to indicate that further categories can be added.

7) Some participants interpreted the marks on the dimensions in the figure as indicators for the categories which raised the question of what the spaces between these marks could be about. Originally, the marks were meant as demarcations and the spaces in between those marks should represent the categories. To prevent such misunderstandings in the improved figure we added the categories' label, which now clearly refer to the spaces in between the marks.

In the light of these aspects the Delphi brings about a revised display of the generic model of research designs in subject-matter didactics (Fig. 2):

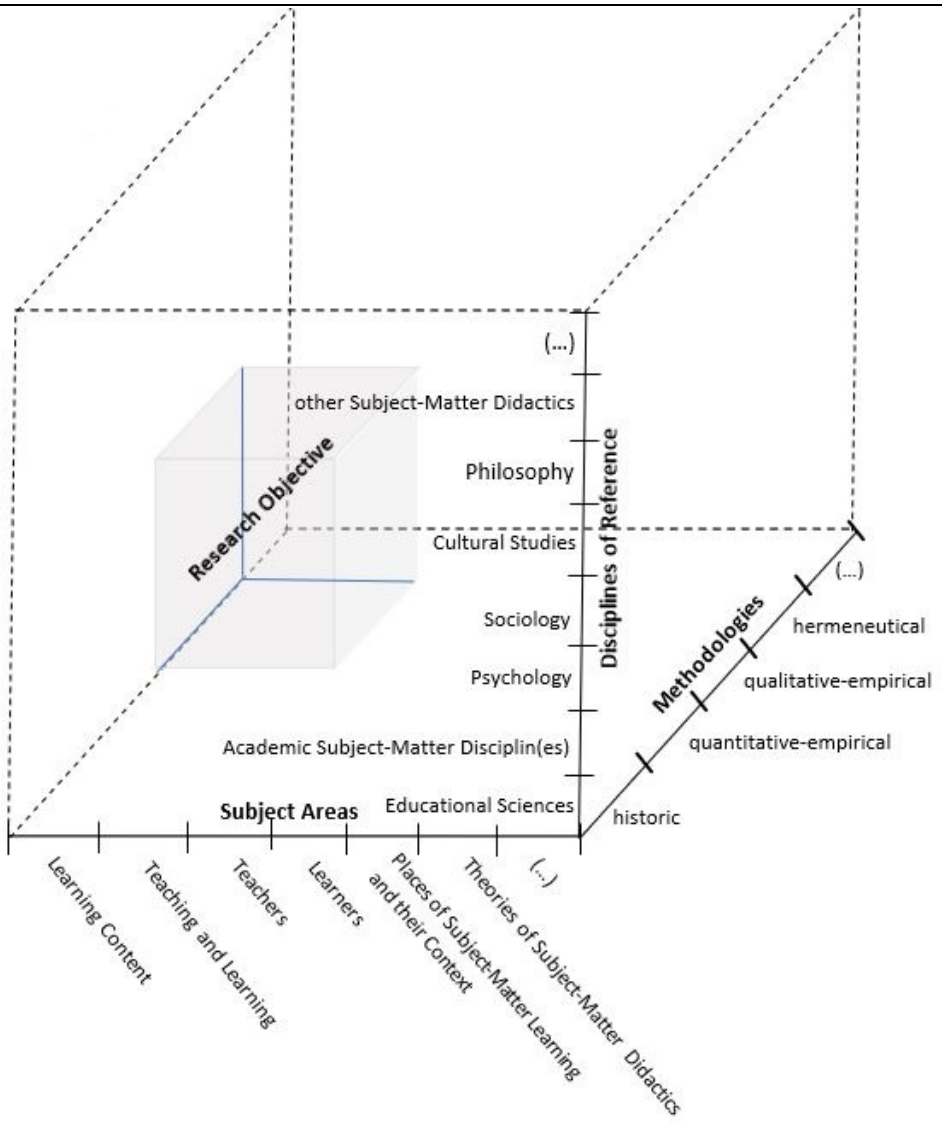

Fig 2 Revised Generic Model of Research Designs in Subject-Matter Didactics

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Research designs define a particular space of research (see fig. 2). This space is constituted by the three dimensions of subject areas, disciplines of reference and methodologies. Basically, this space is well-defined, which means that it cannot be thought of as arbitrarily large. There might be five basic methodologies used in research or even seven, but never one hundred. This well-defined character of the space is indicated in figure 2 by the cube. Note, that each dimension is of categorial character, not of an ordinal or even a metric one. Subsequently, the sequence in which the categories of each dimension are listed is irrelevant. This cube, however, is not set in stone. If a new research object becomes prominent in the field or a new basic methodology will be added to it, the relevant dimension has to be supplemented. In figure 2 this principal openness of the space of research is represented by the categories "(…)" on each dimension.

In order to illustrate how the model works an exemple of a research design has been entered into figure 2 (grey cube). The exemple is design-based research (Prediger et al., 2015). Its characteristic research areas are both learning content and teaching and learning, so the cube representing this design covers the space of the relevant categories on the dimension "Subject Areas". In terms of methodology, it combines empirical and practice-oriented approaches to the field which defines the methodological side of the cube. Finally, for reasons of simplicity, we suppose that besides the relevant academic discipline(s) and educational sciences psychology also plays a characteristic role in this research design. So, the cube covers these three categories on the dimension "disciplines of reference". The grey cube entered in figure 2 exactly covers the space made up by the relevant categories on each dimension. According to this algorithm it is possible to display each research design in the field of subject-matter didactics. To stimulate such cross-disciplinary discussion within the academic field of subject-matter didactics is the intention that has driven the development of this model and the relevant Delphi.

The categories displayed in figure 2 are the result of the presented Delphi study. They are the outcome of shared expertise and cover the range of the research in the various disciplines of subject-matter didactics. In consequence, some of the categories might be more relevant in one of these disciplines, others might be more relevant in other disciplines. In this regard, the results of the Delphi study reveal similarities and differences between the subject didactics and thus offer a potential to interdisciplinary discussion. This can be seen e. g. in the research dimension methodology: While from the perspective of mathematics didactics the distinction between qualitative and quantitative research can be regarded as sufficient, in the context of religion didactics the distinction between historical, hermeneutic, empirical, comparative and practice-oriented methodology is common. The present study provides arguments pro and contra for such differences and makes suggestions for the different disciplines of subject-matter didactics, which in turn offer impulses for further discussion about the understanding of research in subject-matter didactics. This discussion may enable a more effective transfer of knowledge and expertise between the different disciplines of subject-matter didactics.

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