

Knowledge generation between design, data and theory: Argumentation in design-based research

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Appendix

Table 1: Types of outcomes from DBR (going beyond the intervention itself)

	descriptive	prescriptive (design)	prescriptive (design process)	conceptual	questioning	person-related
Van den Akker, 1999		substantive design principles	methodological or procedural design principles			
Edelson, 2002	domain theories	design frameworks	design methodologies			
diSessa & Cobb, 2004 ¹		frameworks for action, domain specific instructional theories		ontological innovations		
Bereiter, 2014		principled practical knowledge ²				
Hoadley & Campos, 2022	domain theories	design principles or patterns	design processes	ontological innovations	new hypotheses and questions	design researcher transformative learning (DRTL)

Table 2: Article overview

Author(s)	Year of publication	Title	Study's purpose/contribution	Leading/research question(s)	Design	Reported outcomes	Character and key argument(s) (if recognizable)
Adams, Britt, Rotsaert, Tijs; Schellens,	2020	Pre-service teachers as designers in the context of advertising literacy education	"The present study explored the use of TDTs in pre-service education for the purpose of making several contributions to the current literature about factors that determine the success or failure of collaborative design processes among (student) teachers."	"RQ1: Which individual characteristics typify student teachers at the start of the design process? [input] a. What are pre-service teachers' motivations to participate and personal reform ambitions? b. What are pre-service teachers' existing design	Teacher Design Teams in pre-service teacher education	Intervention, material designed by students during in-	Exploratory multiple-case study leading to design conjectures, empirical focus

¹ diSessa & Cobb are mentioning more kinds of theories (grand theories, orienting frameworks) which are useful in design experiments, e.g. as a background. The table is limited to theories which are developed (further) in the process. However, the delimitation is not that clear from the text itself, as is the category assignment.

² For a differentiation between design principles and principled practical knowledge, see Kidron & Kali, 2017, p. 5.

Tammy; Valcke, Martin				experiences? RQ2: How do team interactions evolve during the design process of an in-school program about advertising? [process] RQ3: How do pre-service teachers reflect on [outcome]: a. The use of TDTs? b. Their designed learning materials?"		intervention, domain theory, design principles/conjectures for TDTs, new hypotheses	
Augustsson, Dennis	2021	Expansive Design for Teachers	"This article is exploring how Cultural Historical Activity Theory (CHAT: Engeström, 2015) can be used to structure and analyse a co-design process for teachers."	"1. What empirical manifestations of the epistemological principles of a CL can be found in a small-scale intervention for teachers as part of a PD process? 2. How can a combination of tools from PD and CL be productive for co-design efforts in educational settings?"	International and cross curricular learning design on marine biology for upper secondary schools	Intervention, Design Researcher Transformative Learning (DRTL), design processes	Change Laboratory as a design tool: proof of (process) principle
Bogaerds-Hazenberg, Suzanne; E-vers-Vermeul, Jacqueline; van den Bergh, Huub	2020	Teachers and researchers as co-designers? A design-based research on reading comprehension instruction in primary education	"By engaging teachers in a design-based research project, we aimed at designing an intervention for text-structure instruction, and simultaneously gaining more theoretical insight. Also, we intended the teacher design team (TDT) to become more aware of effective practices for the teaching of reading, and to engage more in intelligent decision making on what they should teach (Dewitz & Jones, 2013)."	"RQ1: How viable are the design principles in practice (i.e. how did the four teachers implement and adapt the design principles)? RQ2: What level and type of support do teachers need to successfully translate the design principles into practice?"	Lesson series for reading comprehension at elementary schools	Intervention, design principles , DRTL, design processes	Implementation of theoretically developed design principles (conjectures), test/refinement of design principles by iteration
Brahm, Taiga	2017	Design-based research in the context of transitioning to VET: Developing interventions through research-practice collaboration	"First, based on the research project, it aims at describing the whole research process in order to illustrate how design-based research can be conducted in the context of vocational education. Second, it aims to discuss how formative and summative evaluation can help to reach the dual goal of DBR, i.e. problem solution and research contribution."	"How can a design-based research process be conducted?"	three interventions to foster adolescence' resilience	(Widely implemented) intervention, teaching/learning material, design principles, new hypotheses, (design processes)	Review on a whole project with several cycles: design refinement by iteration/formative evaluation, transfer measurement in summative evaluation
Brown, Barbara; Friesen, Sharon; Mosher, Ronna; Chu, Man-Wai; Linton, Kirk	2021	Adapting to a Design-Based Professional Learning Intervention	"In elaborating on the details of the design, enactment and refinement phases of a professional learning series and the responses of the participants during each of the phases, this article contributes to the literature with a description of recursive and elaborate practices of teacher professional learning with a group of teachers that were new to this non-linear model of professional learning. Through the findings, this study offers pragmatic and theorized descriptions of teacher participation in and adjustment to such practices."	"How did teachers respond to the design, enactment and refinement phases of the DBPL series?"	non-linear and multi-occasioned design-based professional learning (DBPL) intervention to strengthen teachers' assessment literacy and practice	Intervention, domain theory	Study with a focus on qualitative evaluation results, design narrative
Collenberg, Michèle	2020	Entwicklung von Gestaltungsprinzipien zur Förderung	„Das übergreifende Ziel dieses Artikels ist es, den Evaluationsprozess näher zu reflektieren. Dazu wird	„Wie kann eine Lernumgebung gestaltet werden, die die Förderung interkultureller Lehrkompetenz in der Lehrerbildung für die Sekundarstufe II anstrebt?"	innovative learning environment for the promotion of intercultural	Intervention, design principles	Sub-study with a focus on formative evaluation, robustness by variation,

		interkultureller Lehrkompetenz	insbesondere die Entwicklung der Gestaltungsannahmen über zwei Evaluationszyklen hinweg zu Gestaltungsprinzipien näher ausgeführt.“		teaching competence in teacher education		validity by data triangulation
Delius, Katharina	2022	Wie Wissenschaft und Praxis Fachunterricht gemeinsam weiterentwickeln können: Eine Design-Based Research-Studie zur Förderung der Sprechkompetenz im Englischunterricht	„Anhand der DBR-Studie zur Förderung der Sprechkompetenz im Fremdsprachenunterricht soll exemplarisch gezeigt werden, wie ein solches fachdidaktisches Forschungsprojekt strukturiert sein kann und wie mit Hilfe von DBR Entwicklungsprozesse im Fachunterricht angestoßen und umgesetzt werden können.“	Guiding question: „Wie können Unterrichtseinheiten, die einer Kombination von Genre- und dramapädagogischem Ansatz folgen, Lernende bei der Entwicklung ihrer fremdsprachigen Sprechkompetenz fördern?“	Teaching unit in the English language classroom based on a novel synthesis of the genre and the drama-based approach	Intervention, design principles, design processes , domain theory	Documentation of an entire project with methodological commentary; reflection of cooperation, evaluation, design narrative and outcomes
Den Heijer, Pamela; Zondervan, Ton; Voogt, Joke	2022	Shifting Higher Vocational Education Teachers' Response Toward Inward Affective Involvement in Ethical Dilemmas: Perspectives on the Design of Affective Learning Experiences to Inform Students' Attitude Toward an Ethical Dilemma	“This study aims to inform the analysis and exploration of the problem of our overall design-based research project.”	“(1) How do teachers in higher vocational education respond to an ethical dilemma and (2) how do their reflections upon this experience inform the design of learning experiences to stimulate their own students' inward affective involvement in ethical dilemmas?”	Ethical dilemma and questions	Domain theory , design conjectures, new hypotheses	Qualitative study informing the problem statement of a DBR project; research for design
Di Biase, Rhonda	2020	Using design-based research to explore the influence of context in promoting pedagogical reform	“The aim of the paper is to reflect on a completed design-based research (DBR) project. Reporting from a doctoral study, this paper explores how DBR was used to investigate the well-documented implementation challenges of pedagogical reform in a low-resource, developing country context.”	<i>Questions of the project, not answered in the article itself!</i> “The overarching research question of this study was: How can teachers enact active learning pedagogy within the Maldivian education system? The three sub-questions that supported this study were: 1. What form does active learning pedagogy take in the Maldivian context? 2. What are the enabling conditions that support the use of active learning pedagogy? 3. What are the factors that hinder the use of active learning pedagogy?”	Learner-centred education (LCE) at a Maldivian island school	Intervention, <i>reference to design principles published in an earlier article, (design processes)</i>	Documentation of an entire project with methodological commentary; explicating multiple DBR rationales
Euler, Dieter; Collenberg, Michèle	2018	Design-based research in economic education	„This article describes the phases of a design-based research (DBR) process using the example of an economic education project.“	“1. Which concrete learning objectives characterize economic education that integrates ethical-reflective competences in upper secondary schools? 2. How can these learning objectives be promoted within	„Urban economy“ teaching arrangement	Intervention, didactic concepts and materials, design principles , domain theory, (design	Comparison of DBR and impact-based research with short presentation of an entire

				the context of concrete didactic interventions?" "How can DBR's potentials and limits be assessed in summary? What are the specifics compared to empirical impact-based research?"		processes), methodological findings	project (as example); cross-situational findings and conjecturing
Gerholz, Karl-Heinz; Ciolek, Sebastian; Wagner, Anne Christina	2020	Digital design of design processes – A case study of a design research study in vocational education	"The focus of the article is to illustrate the use of digital technologies and tools for co-operation between practitioners and researchers during the phases (design, implementation and evaluation) in a Design Research project."	"The question, thus, arises how digital technologies and tools can support activities in Design Research projects, especially regarding the inter-connection between researchers and practitioners."	Pedagogical prototypes for the usage of tablets in vocational schools	Intervention, design processes	Case study with a (design) process focus
Gössling, Bernd; Daniel, Desirée	2018	Video analysis in Design-Based Research – Findings of a project on self-organised learning at a vocational school	"[T]he aim of this paper is to present the documentary method as a feasible way of generating insights from video data."	"[H]ow can insights gained through the collection and analysis of video data be exploited to enhance designs and develop theory in DBR?" "[T]he following research question will guide the video analysis in the case study: how do students deal with self-organised learning? This question can be split into the following sub-questions: • Which multi-modal utterances feature the videotaped students' interactions with one another and with their teachers? • Which iconological meaning is documented in the video-taped interactions? • Which collective frameworks of orientation guide the students' classroom interactions?"	Self-organized learning at a vocational school	Intervention, domain theory, DRTL, new hypotheses, methodological findings	Case study to illustrate method use in a DBR project; joint analysis contributes to discursive decision-making
Gössling, Bernd; Grunau, Janika	2020	Validation arrangements for formally low-qualified staff in geriatric care: The Design-based Research project KomBiA	"This paper aims to review the research and development work conducted within the KomBiA project as a case study for Design-based Research (DBR). The main objective of KomBiA was to generate tested validation arrangements that remove barriers for the participation of older employees and at the same time ensure the qualification standards of formal training and education systems, thus allowing to possibly obtain an approved degree that includes the recognition of prior learning at the workplace."		Validation arrangements for geriatric care	Intervention, design principles , DRTL, awareness in the field	Review of an entire project; working design by integration of perspectives
Grunau, Janika; Gössling, Bernd	2020	Cooperation between research and practice for the development of innovations in an educational design project	"This paper aims to establish a better understanding of how cooperation among researchers and practitioners can be managed and how cooperation is related to the design and implementation of innovations. For this purpose, we draw on a DBR project as an example, wherein the European model of validation was adapted to the field of geriatric care in Germany."	"Which role does cooperation between research and practice play in developing the design and enabling the implementation of innovations through a DBR project?"	Validation arrangements for geriatric care	Intervention, design processes	Cooperation narrative structured by design process principles

Hanke, Erik; Hehner, Stefanie; Bikner-Ahsbals, Angelika	2021	Reducing Fragmentation in University Pre-Service Teacher Education	“These questions lead to the two types of interrelated findings in design-based research: findings from design choices and from theory building. The first research question addresses the development of teaching designs involving a specific design principle. The second and third research questions aim to reconstruct conditions of success, as well as theoretical and empirical insights to be included in the re-designs (see Prediger, 2019). This way, we achieve three interconnected results: A design principle, a conditional model of success for linking subject matter and subject matter didactics, and a concept for how pre-service teachers enact this linking in their thinking and acting.”	“1) Which design characteristics of courses for subject matter and subject matter didactics in teacher education programmes foster the linkage between course contents? 2) Which conditions foster or hinder the formation of links between subject matter and subject matter didactics, both on course level and in pre-service teachers’ thinking and acting? 3) In which ways do pre-service teachers relate course contents from subject matter and subject matter didactics in their thinking and acting?”	innovative teaching formats, which dovetail subject matter and subject matter didactics on the curricular level in different subjects	Intervention, “transfer package” for teachers, design principles, domain theories , design processes, ontological innovations, new questions	Comprehensive study suggesting generativity of design principles and other theoretical outcomes by designing teaching formats and analysing students’ learning in two distinct subjects
Hanna, Amelie; Conner, Lindsey; Sweeney, Trudy-Ann	2022	Conducting online design-based research: START e-business training as an educational intervention	“This study aims to assess an intervention that helps improve business skills, computer skills, and English skills to optimise the training for better learning outcomes in each cohort as the intervention progresses.”	“1) What is/are the educational theory/ theories that inform this study? 2) How can the intervention be designed and implemented to enhance business skills, computer skills, and English skills simultaneously? 3) What tools and processes will assess the learning outcomes of Arabic-speaking trainees? How can formative and summative assessment outcomes be used as data for the research process? 4) How do components of the learning process contribute to evaluating the effectiveness of the training program and inform iterative changes in the educational design?”	E-business training for Arabic-speaking trainees	Intervention concept, pre-use evaluation results (work in progress)	Early-stage project report including design, first pre-implementation refinement, implementation and evaluation plan
Kidron, Adi; Kali, Yael	2017	Extending the applicability of design-based research through research-practice partnerships	“Our aim in the current work, which we view as Phase II of the research, was to expand the applicability of the BBIL model by enhancing it with practical insights. Therefore, we extended the context for which it was developed in Phase I, and explored the way it was implemented in a very different context - school.”	“How should the integrative lens questions be incorporated in the learning sequence? (Dilemma #4); What are possible formats for integrative artifacts? (Dilemma #6); When should the integrative artifact be incorporated into the learning sequence? (Dilemma #7); How flexible can the deepening and focusing script be?; To what extent should the interdisciplinary moderator understand the disciplinary domains? (#Dilemma #10)”	Boundary Breaking for Interdisciplinary Learning (BBIL) instructional model for middle-schools	Intervention, design principles (commented version based on phase I principles), domain theory, design processes, new questions/hypotheses, DRTL	Study with implementation focus; context-design fit by research-practice partnership
Lambert, Deborah; Jacobsen, Michele	2020	Implementing an Intervention into a Grade Six Learning Environment: A Design-Based Research Framework	“Educators in some Canadian schools are especially challenged in developing innovative pedagogical approaches that can intellectually engage their students in deep learning of core curriculum content, while equipping them with 21st century competencies. In this paper, we discuss some key ideas on how an intervention, the design and building of digital video games, was implemented and ex-	“(i) In what ways do teachers’ design of instruction and learning tasks need to shift when designing and building digital video games to intellectually engage students in deep learning of curriculum content and to develop and use 21st century competencies, in school? (ii) In what ways does the design and building of digital video games in school impact students’ intellectual engagement, deep	Intervention to immerse and support grade 6 learners in their learning of the decision-making method using a	Intervention, domain theory, design processes	Short-term project report; objectivity and reliability by data triangulation; better design by practitioners’ input

			pored, to address this challenge, in four grade 6 social studies classes at a Calgary charter school, utilizing a design-based research framework.”	learning of curriculum content and the development and use of 21 st century competencies?”	historical model of decision-making		
Lehtonen, Daranee	2021	Constructing a design framework and design methodology from educational design research on real-world educational technology development	<p>“Informed by the literature and my direct experiences of working in collaboration with teachers and various disciplines during this EDR on technology-enhanced learning, this paper seeks to further knowledge of: 1. Design frameworks: key aspects to be taken into account when developing educational technologies to ensure their educational benefits, feasibility, and successful real-world utilisation and adoption. 2. Design methodologies: guidelines for successfully conducting EDR.”</p> <p>“This study employed an EDR approach to bridge the gap between research on manipulatives and its direct practical contributions to real-world educational challenges (i.e., the disagreement between manipulatives’ pedagogical benefits and classroom practice). It aimed to investigate the use of manipulatives in real educational contexts and then to develop a research-informed manipulative that not only enhances primary school students’ understanding of equation-solving concepts, but also promotes its utilisation and adoption in the classroom.”</p>		Intervention using manipulatives (tablet application and related physical objects) to enhance students’ mathematical concept understanding in primary and lower secondary schools	Intervention, design framework, design methodology , DRTL, (reference to domain theories, published before)	6-year project overview combining different lines of argumentation: theoretical understanding by iteration / reliability and validity through data triangulation / good design and understanding through participation / better context understanding and confident decisions by working with alternative designs
Moreno, Rhia; Kilpatrick, Jeffrey	2018	Student perceptions of self-efficacy in the foreign language classroom: A design-based research study	<p>“The purpose of this qualitative study was to address how to build task-specific self-efficacy through curricular interventions.”</p> <p>“The objective of this study was to apply theory to pedagogical application with the goal of improving the language learning experience for current and future students.”</p>	“1. How does increased exposure and productivity affect students’ perceived self-efficacy? 2. What areas of FL learning classroom environment impact students’ sense of self-efficacy?”	Flipped collegiate foreign language course with “Free to Err” elements	Reference to dissemination of findings in multiple contexts; intervention , domain theory, new hypotheses, (design principles)	Three cycle study focusing on qualitative analysis; better design through dialogue
Raatz, Saskia; Euler, Dieter	2017	Responsible leadership in management education: A design-based research study	“We report the results of a study that starts with an ambitious and yet ill-structured learning goal in a demanding educational practice area.”	“How can pedagogical interventions in management education be designed to promote learners’ attitudes to responsible leadership? • How can attitudes to responsible leadership be fostered in the classroom? • What challenges do academics face when applying pedagogical concepts meant to change students’ attitudes? • What are the principles of learning for responsible leadership?”	Intervention for responsible leadership in MBA program	Intervention, normative concept, domain theory, design principles	Study building on validity across design cases
Segerby, Cecilia;	2018	Primary students’ participation in	“[T]he present study focuses on creating a collaborative intervention study that attempts to support students’ reasoning in school mathematics. As such,	See aims	Intervention combining reciprocal teaching	Intervention, domain theories, design principles	Design narrative across three mathematical settings

Chronaki, Anna		school based mathematical reasoning practices: Coordinating reciprocal teaching and systemic functional linguistics to support reasoning in the Swedish context	the collaborative intervention design coordinates basic tenets from the Reciprocal Teaching approach for identifying appropriate complementary tasks that scaffold mathematical reasoning and Systemic Functional Linguistics for exploring how Grade 4 students embrace reasoning as language use through such tasks. At the same time, the study will attempt to explore and account for the engendered potentialities and boundaries in such an endeavour.”		and systemic functional linguistics to support primary students’ reasoning		
Sloane, Peter F. E.	2017	‘Where no man has gone before!’ – Exploring new knowledge in design-based research projects: A treatise on phenomenology in design studies	“The main intention of this contribution is to reconstruct design research on the basis of a phenomenological approach. As I mentioned at the beginning of my argumentation, one problem in the communication done in design programmes is the reception of those who work with the established, analytical, rational approaches. Often, the background assumptions are not expressed, which often makes communication problematic because questioning the research design then happens without understanding the special assumptions in this kind of research work. Indeed, a long-going tradition of humanities can be claimed with sophisticated arguments for why research in the life-world of practitioners is possible, fruitful, and reasonable. From this point of view, the contribution is an attempt to reflect one’s own work in social fields.”		Teaching and learning units to foster self-regulated learning in vocational schools	Reference to Intervention, “knowledge” (design principles); methodological findings	Theoretical reconstruction of DBR with reference to a case
Sloane, Peter F. E.; Krakau, Uwe	2021	How does didactic knowledge develop? Experiences from a design project	“In this paper, we have tried to concisely present how the work progressed in phases and cycles and roughly described the thought process and evaluations that shaped this project. Perceived this way, this paper serves two different interests. First, it shows how a problem definition was developed and further sharpened and what concrete result was obtained in the process. This is indicated by the subtitle. Second, it explains how knowledge is created and defines the scope and specificity of this knowledge.”	Article-introducing question: “How does knowledge that teachers need occur, especially in practice?”	New curriculum in a vocational college	Intervention, materials (e. g. learning situation construction model), design principles, design processes, DRTL, methodological findings	Theoretical and case study, knowledge by dialogue
Stokhof, Harry; Vries, Bregje de; Bastiaens, Theo; Martens, Rob	2018	To adopt or reject? Testing the robustness of a principle-based scenario for guiding effective student questioning	“This study aims to determine to what extent the scenario for teacher guidance is robust and transferable to other teachers in different primary school settings.”	“What is the robustness of a principle-based scenario for guiding effective student questioning? To address this main question four subquestions are formulated. First, how do teachers perceive the scenario, operationalized as Rogers’ attributes of innovations? Second, to what extent do teachers adhere to the essential and optional activities of the scenario in the operational curriculum? Third, to what extent do teachers experience support for their basic psychological	Scenario for teacher guidance on guiding student questioning in primary school	Reference to intervention and design principles; evaluation results/evidence for robustness	Implementation study focusing on the “decision” stage of implementation; robustness by variation

				needs in the realized curriculum? And finally, if and to what degree do the (co)variables influence the teachers' implementation decisions?"			
Studer, Judith	2021	Gemeinsam verschieden unterwegs	„Die Wissenschaft-Praxis-Kommunikation stellt in Design-Based Research (DBR)-Projekten ein zentrales Charakteristikum dar. Der Beitrag diskutiert auf Basis eines konkreten DBR-Projekts mögliche Ausgestaltungsformen dieser Kommunikation, ihren Mehrwert und die damit verbundenen Herausforderungen.“	„Inwiefern beeinflusst die Wissenschaft-Praxis-Kommunikation die Einführung der pädagogisch-didaktischen Innovation (sprich die Einführung der Lernumgebung zur Förderung der Entwicklung berufsrelevanter Selbst- und Sozialkompetenzen)? - Wie ist die Wissenschaft-Praxis-Kommunikation auszugestalten, damit sowohl die praktische Umsetzung der Innovation als auch der wissenschaftliche Erkenntnisgewinn gleichermaßen erfolgreich erfolgen?“	Learning environment to encourage the development of professionally relevant personal and social skills as part of the BSc program in social work	Intervention, design processes	Study focused on research-practice communication, narrative
Tammeleht, Anu	2022	Design principles for developing online ethics resources - the outcome of holistic DBR process	“The current article outlines the results of DBR (design-based research) about designing an online research ethics resource that gradually develops research ethics and integrity competencies.”	“The focus of the research was the understanding of <i>how to facilitate a learning process so that it would support development of ethics competencies.</i> ”	Online research ethics resource	Intervention, design principles , design processes	Study on a whole DBR project including first transfer to a different topic; robustness by variation