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Exploring the Messiness of Design Principles in Design-Based Research

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Abstract

Design-based research (DBR) emphasises the importance of developing and refining design principles when conducting educational design experiments. However, a review of the DBR literature has shown that there is a lack of clarity as to how design principles are described and applied. In this paper, we introduce a model for articulating design principles, and enabling analysis and discussion of how these might be challenged and undergo transformation during DBR processes in local educational settings. The analysis is based on examples derived from two DBR projects relating to digital technologies. The first example is taken from a large-scale intervention project that demonstrates the importance of teachers' different dialogic approaches to teaching design thinking with Scratch. However, the rationale of large-scale project design does not allow for the integration of this emerging knowledge. The second example focuses on how a practitioner–researcher faces and manages preservice teachers' preoccupation with the curriculum, when trying to enact a design principle in a lesson within the module “Technology comprehension and digital bildung” with playful approaches to learning. The two examples illustrate how the presumably linear process of articulating design principles and gradually refining them through design experiments in practice should be seen as a far more “messy” or contingent process than is presented in most DBR methodologies. We raise the case that the realisation of design principles must address possibilities for achieving (and not achieving) agency among local educators and students. This points to a pragmatic need for rethinking and reconstructing DBR approaches in ways that pay more attention to the messiness of local adaptations and the emergence of new design principles.

Keywords

Design-based research, design principles, agency, education

Introduction

Design principles are probably the most prevalent term used to characterise the theoretical understanding developed through iterative processes of educational design research. However, Gundersen (2021) finds in his review of 45 DBR studies that only one study reported on the development of guiding principles into conclusive or refined principles.

Others did not mention design principles at all, or only put forward the guiding principles and then went on to conclude something else. Moreover, it is often not clear how specific design principles are articulated, who they address and how they are carried out in practice, despite attempts to clarify the term (van den Akker, 1999; Baumgartner & Bell, 2002; Bakker, 2019). In this way, it can be argued that DBR tends to favour idealised descriptions of design principles, rather than producing relevant and robust guidelines for educators and researchers to test and use in their relevant practises, which was initially one of the central ambitions of DBR during its infancy (Collins, Joseph, & Bielaczyc, 2004). This paper sets out to explore this lack of transparency and explicit articulation of design principles by focusing on what happens when design principles are applied in real-life teaching and learning settings.

DBR researchers often rely on educators to carry out their principles in their practice to test their usefulness. Practises underly different possibilities and constraints. Through two empirical examples, we will show that the development and implementation of design principles often involve more “messy” or contingent processes of local negotiation than is suggested in most DBR literature. These negotiations may lead to unexpected findings beyond the aims of the originally planned design principles. Messiness is a well-known term within educational action research, where researchers engage in the messy practice of negotiating with practitioners on the contingent aims, methods and outcomes of the research process (Cook, 2009). Similarly, we regard messiness as an inherent aspect of any DBR intervention, even though there is a tendency in the DBR literature to present findings as the result of a linear refinement process towards a predefined goal. This means that we do not regard “mess” as a negative aspect of conducting DBR but as a basic condition when educational researchers explore design principles in “the swampy lowlands” (Schön, 1983, p. 42) of front-line practice. This points to a pragmatic need to analyse the possible impact and local adaptations of design principles and how the enactment of design principles always involves different forms of agency and responses from the involved social actors. Accordingly, in this paper, our research question is as follows: How can researchers articulate design principles in DBR and understand the agency achieved by educators and students when enacting design principles? We will address this question by first presenting a model for understanding key aspects of design principles and then describing two examples that show the messiness of enacting design principles in real educational contexts.

The role of design principles in DBR

The importance of design principles has been emphasised by several DBR researchers, who suggest that they should serve to guide interventions and support the creation of new knowledge (van den Akker, 1999; Baumgartner & Bell, 2002; Gundersen, 2021). Design principles should be articulated in order to transform theoretical assumptions into specific guidelines that may address specific technological affordances, teachers’ pedagogical approaches, or scaffold specific student tasks. In this way, design principles articulate intentions that can be applied and further developed through interventions in order to generate domain-specific knowledge.

Nieveen, McKenney and van den Akker (2006) suggest that DBR studies can be divided into either *validation studies* or *development studies*. Validation studies feature the design of learning trajectories to develop, validate and elaborate on theories about the process of learning and the implications for learning. In development studies, the fundamental aim is to develop design principles (van den Akker, 1999) for use in practice. Research is problem-driven, situated in the educational field and involves close interaction between practitioners,

researchers, experts and other stakeholders. However, development studies may sometimes also be more explorative, as they seek to investigate new potentials, especially in the early stages of a research project (van den Akker, 1999). The guiding principles of an intervention can thus originate from either an existing theory (to be validated) or grow in the form of a problem or potential from an existing context (to be mitigated, explored or solved).

According to van den Akker (1999), it is important to discern between two aspects of a design principle. The first aspect is *substantial* – that is, the characteristics of the design itself. Substantive design principles can partly be extracted from prototype testing, which is one of the reasons why it is profitable early in the design process to analyse existing interventions to generate ideas for new design tasks (van den Akker, 1999). The second aspect is *procedural* – in other words, how the design should be developed or the characteristics of the design approach. Akker suggests that a combination of substantial and procedural principles may support design researchers in their tasks through heuristic statements in a format such as the following:

If you want to design intervention X [for the purpose/function Y in context Z], then you are best advised to give that intervention the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis], because of arguments P, Q, and R (van den Akker, 1999, p. 9).

The intention of the statement is not to guarantee successful interventions, but to generate principles that allow depiction and discussion of the currently most appropriate knowledge for specific design and development tasks.

Baumgartner and Bell (2002) also emphasise the relevance and articulation of design principles within DBR. The authors discuss the inadequacy of theories and explanatory frameworks in coming up with design solutions. Instead, researchers need to develop *generative design principles*, which should be informed by theories and, more importantly, help designers generate new designs to be tried out in practice. While some design principles can be generated after a design process is complete, the argument that these authors put forward is that in order to be useful, design principles should be accessible from the beginning of the research process (Baumgartner & Bell, 2002). As opposed to being explanatory in terms of giving reasons for an intervention being successful, useful design principles are generative in nature, leading designers to come up with new designs on the back of the guidance provided by the existing principles. This also involves creating *criteria* for evaluating usefulness (e.g. learning, goals, available class time, technical specifications, etc.), which can be used to assess the value of specific design principles.

To develop and explore design principles, Baumgartner and Bell (2002) suggest that researchers may benefit from addressing key questions, such as *who* is to apply the principles, what characteristics do the principles have, and how should the principle be applied. In addition to these questions, we wish to argue that design principles always need to reflect a *why* – that is, why is the principle carried out? This reiterates van den Akker's (1999) emphasis on the specific purposes of arguments for applying design principles. These problems or potentials may be founded on different demands and theories put forward by different stakeholders, which could be internal (e.g. teachers or students) or external (e.g. funding agencies or educational designers) with a specific interest in validating the effectiveness of a given approach. It is, therefore, important that DBR manages to clarify what forms of knowledge or agendas influence specific design principles (cf. Buhl et al. (2022) in this special issue).

Based on the discussion and categories above, we have created a model (shown in Figure 1), which illustrates how the articulation, enactment and assessment of design principles must address five key questions:

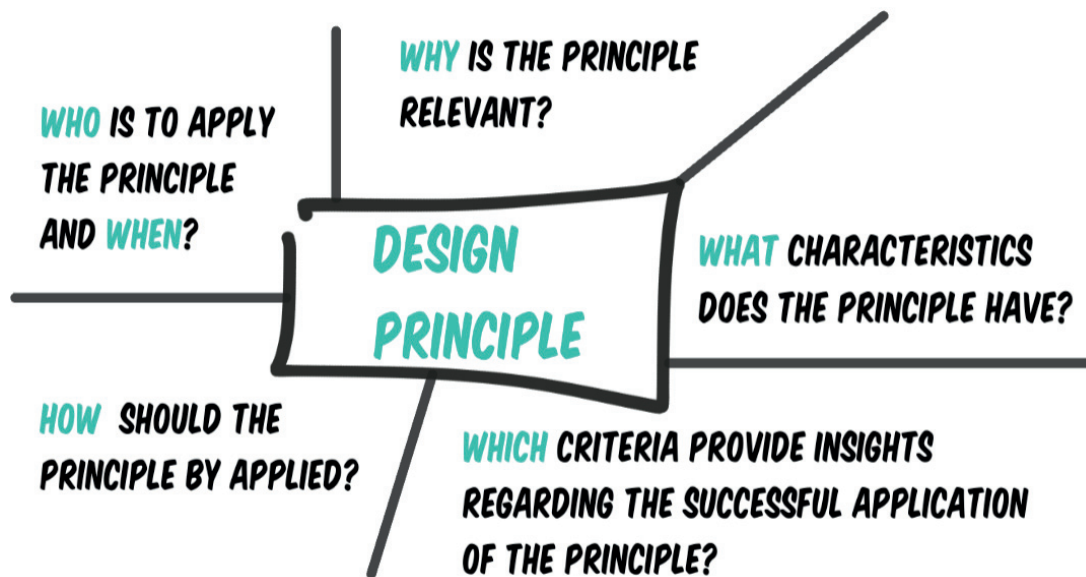


Figure 1 Aspects of design principles

We propose that the model could be used as a heuristic tool for asking key questions when articulating, enacting, exploring and evaluating design principles during DBR processes. The questions in the model should be asked continually before, during and after iterative design and research processes. This could support researchers in navigating the contingency of DBR projects, which leads to the abandonment or revision of initial design principles, as well as the emergence of new design principles.

Exploring the relations between design principles and agency

Doing DBR research and trying out design principles always involve the emergence of unexpected outcomes, where multiple factors may come into play (Design-Based Research Collective, 2003) (see the questions raised in Figure 1). In this paper, we wish to emphasise that the enactment of design principles often involves “messy” responses from practice, which are crucial to address and understand as a part of the research process. In order to address the complexity of messy responses from design interventions, we will introduce a relational notion of *agency*.

According to Priestley et al. (2015), agency is conditioned not only by the individual themselves and its preconditions for making choices but also by the surrounding conditions: “We do not see agency as a capacity of individuals, that is, as something individuals can claim to ‘have’ or ‘possess’, but rather see it as something individuals and groups can manage to achieve – or not, of course. Agency is therefore to be understood as resulting from the interplay of individuals’ capacities and environment conditions” (Priestley et al., 2015, p. 3). Thus, the achievement of agency will always depend on the interplay of individual efforts, available resources and contextual and structural factors as they come together in locally defined situations. In this way, it becomes possible to describe how design interventions may involve widely different interests, power relations, resources and contextual constraints. The

relationship between design principles and agency is dialogic. First, the enactment of specific design principles may constrain or enable the agency of educational actors. Second, the agency achieved by teachers and students may respond to the researchers' further articulation and transformation of design principles.

Design principles in practice: Two examples

We will now present two examples of how design principles have been enacted in DBR research that focus on the messiness involved when educators adopt digital technologies in the classroom. Focusing on the achieved (and not achieved) agency of social actors in educational settings, the two examples have been chosen to illustrate how design principles may be inadequate when realised in practice. Moreover, the two examples have been chosen in order to demonstrate variations in how different DBR research types allow for different possibilities for enacting agency by realising design principles, as well as how educators and students may respond to them. The first example concerns a large-scale validation study, and the second example is a small-scale development study. Each example will focus on how specific design principles are articulated based on particular research agendas, how they are enacted in practice and how these enactments result in transformations that call the original design principles into question. Our analytic focus is on how agency is conditioned in each study when trying out design principles in practice, and how this may lead to the emergence of new and “messy” knowledge that differs from the research intentions.

Example 1: Teaching Design Thinking with Scratch

The first example has been chosen to illustrate the challenges of articulating and revising design principles within the context of a DBR validation study that involved limited possibilities for the professional development of teachers. The example comes from the project Game-Based Learning in the 21st Century (GBL21), which involved a large-scale RCT intervention that aimed to develop design competencies for approximately 1,500 students (grades 5–8) from 19 schools, working with game-related design activities in the subjects of Danish, mathematics and science over a time span of two years (2019–2021). The overall assumption of the project was that students would develop design competencies in terms of ideation, modelling, empathy and process management by taking part in design thinking activities using game tools.

The empirical example is taken from a pilot study documenting a GBL21 teaching unit that invites students to work with a design-thinking approach to the visual programming tool Scratch (<https://scratch.mit.edu>) (Hanghøj et al., 2019). The teaching unit was based on a set of generative design principles articulated by the research team based on a review of existing research within the area (Rusmann & Ejsing-Duun, 2020). This involved the creation of online learning materials and teacher guides, which should support students when working with a specific design challenge within the curricular context of mathematics education (i.e. learning about geometry by constructing a Tangram game in Scratch that other students should be able to play). The teacher and students were asked to go through the five phases of the design thinking process, which involved 1) exploring a problem, 2) interpreting findings and focusing on the problem, 3) ideation, 4) building prototypes, and 5) testing them on their peers. The study assumed that the students would achieve agency and develop design competencies by taking part in the design thinking process, as well as learn mathematical content about geometry through the construction of Tangram games.

Enacting the design principle in practice

In this example, we will put special emphasis on the “how” and “which” aspects of the GBL21 design principles (see Figure 1) – that is, *how* the GBL21 design principles were applied in practice within a classroom context and *which* criteria provided successful insights regarding the implications of the principles. The example is based on an analysis of video recordings of a pilot study documenting how two mathematics teachers (P and A) introduced the teaching unit (Hanghøj et al., 2019). The recordings show important variations in the application of the design principles – that is, the two teachers’ pedagogical approaches to teaching design thinking activities in relation to the Scratch software.

In summary, Teacher P decided not to follow the facilitation process described in the teacher guide for the unit. Instead, he lectured in an authoritative discourse, explaining how the program worked and only asking students to answer relatively closed questions. When introducing the first task of the unit, Teacher P focused on what the students should do (e.g. “You have to do this sequence of commands on your computer”). Consequently, the students mechanically typed the commands, mostly individually, without reflecting on how the commands functioned. Most students finished the task rather quickly, without knowing what to do next. After 20 minutes, Teacher P showed the whole class his own solution and went over some technical details. Only then did P ask the students about their work but without following up on their contributions. Generally, P interacted with students in whole-class sessions in an authoritative way, focusing on specific points of view and occasionally allowing them to answer closed questions. On no occasion did P invite students to propose new ideas or pose an open question to explore different points of view or ideas.

In comparison, Teacher A started the introduction to the unit by encouraging the students to explain the key mathematical concepts in the lesson and provided a drawing on the board for them to use in their explanations. During the lesson, Teacher A repeated a cyclic pattern four times, which first introduced the (next) task in an explorative way (e.g. “What do you think happens in this script?”), inviting students to find out for themselves and providing them with time to do so. Second, A helped students work on the task, encouraging them to try out their own ideas. Third and finally, A led classroom discussions based on their work with the task, inviting them to contribute their different viewpoints and sometimes asking specific students to share their contributions.

Based on teacher interviews, it was clear that Teacher P had considerably more experience and competence in teaching programming than Teacher A had. By lecturing about his knowledge of programming, P left few opportunities for the students to achieve agency and develop design competences. By contrast, A used a lack of programming skills to invite the students into a shared exploration of Scratch and the game design activities. In this way, Teacher A’s approach was more fruitful than the authoritative approach used by Teacher P in terms of enabling interaction, conceptual development and student engagement in the lesson. This unexpected finding showed the research team that the teachers’ ability to facilitate dialogic interaction with the students in relation to their game design processes was a key criterion for the GBL21 project to succeed (see the “Which” aspect in Figure 1).

Transformation of design principles

In response to the findings, the research team revised the original GBL21 design principles by emphasising the importance of engaging in dialogic interactions with the students in relation to programming tasks. This resulted in two new design principles, which were more detailed in terms of stressing *how* to scaffold students’ work with material objects – especially programming tools – in relation to mathematics. At the macro-level of the classroom,

it was seen as important “to engage students early in working with the material objects through explorative processes such as not-trivial, subject-related constructions” (Hanghøj et al., 2019, p. 8). Similarly, at the micro-level, it was important “to scaffold classroom interactions in order to enhance constructive dialogues as regards both the subject matter, the material objects and not the least their interrelationships” (Hanghøj et al., 2019, p. 9). However, due to the large-scale project design of the RCT study, which required high fidelity and a fixed linear structure, it was difficult to incorporate additional guidance for dialogic teaching in collaboration with the participating teachers. Consequently, the project teachers were mainly positioned as implementers of the researchers’ design principles, which sometimes led to the experience of limited agency (Hanghøj et al., 2020). In this way, this example shows how difficult it is to integrate design principles within the context of a large-scale validation study where there are insufficient local possibilities for supporting teachers’ professional development.

Example 2: Facilitating a playful approach to digital technologies in teacher education

The second example is taken from an ongoing Ph.D. project within the Danish Playful Learning Research Extension Project. The PhD project is being conducted in the context of the newly established mandatory module, “Technology comprehension and digital Bildung [Teknologiforståelse og digital dannelse]”, in Danish teacher education. Taking a practice-oriented approach, the study represents a development study in which the aim is to articulate design principles, and investigate how the interplay between digital materials and physical activities supports preservice teachers’ playfulness and embodied presence. This example illustrates how a practitioner–researcher, who was both a co-designer and enactor of design principles (Winther, 2015), managed preservice teachers’ preoccupation with curricular aims and constraints when trying to enact design principles in teaching with playful approaches to learning. The example focuses on the “how” and “why” aspects of the model (see Figure 1). The example concerns the need for revision, as well as the emergence of new principles.

Thirty-six educators involved in the Playful Learning Programme articulated three principles of playful learning. Highlighted in this example is the design principle “Imagining together”, which presupposes that “playful learning involves various media, materials and moods that functions as didactic fellow players and open up for wondrous imagination and creative paths to reflection and learning” (Lyager et al., 2020, p. 38). This design principle was articulated for educators to enact in their teaching, and apply preferred pedagogical approaches to the design principles.

The principle was transformed so as to be tested in a pilot project, and this was achieved by the practitioner–researcher with inspiration from Akker’s heuristic. Akker’s heuristic elaborated on the underlying rationale behind the principle, the characteristics of *how* to apply the principles and stated some criteria of success, that is, characteristics of how to apply the principles: “The educator must facilitate a process that ensures the preservice teachers are ready to be involved in a process where they have to be creative, curious, imaginative and playful with different digital materials. Furthermore, the educator must facilitate a process where, throughout the process, the preservice teachers reflect on the materials affordance and what emerges when they try to use it in a different way than what it was designed for.”

Enacting the design principle in practice

Following a post-phenomenological approach (Ihde, 2009), the data collection involved experience and practice narratives, video recordings and fieldnotes from the teaching. This example is from a lesson, which was conducted as a creative digital workshop introducing preservice teachers to multiple digital devices (e.g. programmable mini-computers and robots).

The preservice teachers reflected upon the chosen playful teaching method by asking each other, “What does our teacher want us to do in this task?” and stating, “What I do is not good enough” (Video recordings). These quotes indicate how the intended playful learning environment failed to be a safe space, and that the preservice teachers felt the need to reach a specific learning goal, instead of exploring the digital materials more openly (Händel & Buhl 2021). In addition, some preservice teachers were more occupied with the setting, and experienced a lack of connection with the playful content of the workshop, asking the practitioner–researcher questions such as: “We are physically present in the lesson, so according to you this is enough to pass the teaching unit for today, right?”. Some students would react to the playful teaching method by not engaging in the lesson, by looking out the window, for example. By the end of a lesson, one preservice teacher also stated, “I do not need to achieve technology comprehension or to use playful approaches to learning when I become a teacher, I am going to be a Danish [L1 subject] teacher” (Video recordings). In this way, the preservice teachers tried to achieve agency both verbally and with their embodied presence by responding to playful teaching.

Transformation of design principles

In this example, there are three situational constraints that are relevant to understanding how the preservice teachers’ preoccupation with the curriculum influences and affects the enactment of the design principles (Gudiksen & Skovbjerg, 2020). The three situational constraints are (1) the preservice teachers being enrolled in a new subject and content, (2) the preservice teachers facing a new teaching method, and (3) the preservice teachers’ preconception of teaching in higher education.

When preservice teachers are enrolled in education, they draw on previous experience and tacit knowledge of being part of an educational setting – that is, knowledge of subject content and teaching methods. In this example, the module challenged their already existing knowledge and experiences. It did so by introducing them to *playful* approaches to learning and an expanded agenda going from “an information and communication technology perspective to also including a critical, social and creative understanding of digital technologies and computing competences” (Lisborg et al., 2021, p. 53).

Based on the agency achieved by the preservice teachers and their critical responses, the practitioner–researcher found it necessary to articulate more specific characteristics of the design principle by expanding the “why” aspect of the design principle (see Figure 1). This was described as follows: “The preservice teachers must achieve competence, skills and knowledge regarding various digital materials affordance throughout the module. However, in order for reflections on learning and technology comprehension to emerge, it is required that the preservice teachers are allowed to imagine and actively experiment with the digital materials also in a way they are not designed for.” Adding a “why” to the existing design principle would help preservice teachers focus on the learning process instead of the curriculum.

In the last part of the pilot project, a webinar was conducted by the practitioner–researcher, involving preservice teachers, colleagues, researchers and other stakeholders. One of the aims of the webinar was to discuss and evaluate the design principle (i.e. imag-

ining together), and further transform the principle to be tested with new preservice teachers in the next semester. The discussion and critical response from the webinar showed that further transformation and new design principles needed to be added to the project. The two added principles were the notion of “fail-ability” (being brave enough to fail and make mistakes) and “learning through an experimental practice” (Händel & Buhl, 2021, p. 570).

Discussion

The two examples show that posing different questions with regard to the enactment of design principles in practice (i.e. the “how” (or procedural aspect), the “which” and the “why”) (see Figure 1) can be used to understand how design principles transform as a consequence of emerging design knowledge that diverges from the original design principles. The first example showed how a set of generic design principles was realised in a teaching unit facilitated by two teachers, where one of the teachers chose to ignore the pedagogical approach of the research project. This made the need for developing new design principles clear, which focused far more on the teachers’ dialogic facilitation of the design-thinking activities. The second example showed how the preservice teachers questioned the practitioner–researchers’ playful teaching methods, as it conflicted with their experience and knowledge of being students in teacher education. Based on this critical pushback, the practitioner–researcher found it necessary to both revise the existing principles and develop new design principles. In this way, the examples show how the researchers in each project attempted to grapple with the messy response when enacting design principles in practice that sometimes supported and sometimes prevented the social actors from achieving agency through local design interventions. This illustrates how there is often a discrepancy between what is intended by a design principle and the response or pushback from practice. In this way, the aim of a DBR research process may be less about refining a design principle through a linear process and more about addressing this discrepancy (e.g. by identifying limitations, transforming assumptions or discovering new design principles).

The analysis of the two examples also suggests that different types of DBR (a validation study and an explorative development study) may involve substantially different possibilities for the involved participants (i.e. researchers, teachers and students) to enact and achieve agency. The validation study in Example 1 aimed to test a theory on teaching and learning (design thinking as a pedagogical approach) by trying out a design principle in its natural habitat to validate its effectiveness. In this way, the design principle was primarily enacted and defined through the agency that was enabled by a specific research agenda, as defined by the project researchers. The project showed how a teacher responded in an unexpected way. From an ecological perspective, the achievement of agency is informed by the teachers’ personal and professional experiences, motivations for alternative future actions differing from the present and past, and the capacity to make practical and normative judgments and alternative actions in response to presently evolving situations. One could assume that teachers like Teacher P, who are able to draw upon a rich repertoire of experience, are more likely to share expansive orientations to the future and responses to present situations than might be the case (Priestley et al., 2015). Despite substantial capacity (skills and knowledge) and strong educational aspirations, innovation may be too difficult. Due to the fixed methodological procedure of the GBL21 project research design, there were limited possibilities for integrating the emerging knowledge on the need to support the teachers’ dialogic facilitation in the large-scale project. By contrast, the explorative development study (Example 2) aimed to explore how problems and potentials in relation to playful learning emerged

in a situated practice experienced by practitioners. Here, the aim was not only to test the theory behind the implemented design but also to improve the practice in which it was implemented, which could eventually be of value in other areas of teacher education. The development study, therefore, had a broader scope than the validation study, as it focused on the emergence of new knowledge through creative and experiential learning processes, and did not necessarily only focus on testing and contributing to knowledge regarding theories of learning. In this way, design principles in development studies may allow for more distributed agency when inviting a broader variety of local actors to engage in the negotiation of design principles.

We argue that the differences between the two research types also reflect a cultural and value-based discussion of teacher agency, which is often overlooked within DBR research. There is a long historical tradition in the Nordic countries and continental Europe for stressing the importance of achieving teacher agency in teaching, as well as in educational research (cf. Gundem & Hopmann, 2002). This bottom-up approach to teaching and research was clearly present in Example 2, where the practitioner–researcher achieved considerable agency in terms of integrating the students’ responses when adjusting and developing the design principles. The practitioner–researcher is likely to achieve agency, as their position as both a developer and enactor of design principles implies social structures in the present moment that are not challenged by different and perhaps opposing experiences, values, beliefs, motivations and possible dilemmas in interpersonal relationships regarding, for example, power and trust. Such dilemmas would naturally apply, and be relevant when using the model as a reflective tool in other DBR projects where the social structures are different and, for example, are conditioned by a researcher who develops and enacts design principles in their colleagues’ profession. Unlike the practitioner–researcher, the students’ agency is limited. They are reflexive and seek plausible explanations for why the design’s “how” and “which” do not match their expectations and previous experiences. However, as a result, the practitioner–researcher articulates more specific design principles for the preservice teachers to focus on in the learning process instead of the curriculum. By contrast, the top-down approach of the GBL21 research project in Example 1 offered more limited options for teachers’ agency. In this way, the implementation of design principles may involve important cultural and political tensions between what is intended by a research agenda and the possibilities of enacting agency at the local level of the classroom (Priestly et al., 2015).

Finally, we wish to acknowledge that working with design principles is challenging. The questions in the model may seem basic, as they are well-known within the research field of “didactics” (Jank & Meyer, 2002). However, as we have tried to illustrate, questions concerning design principles are in fact quite difficult to pursue in practice and, as pointed out by Gundersen (2021), actual descriptions of design principles and their transformations are often omitted in DBR publications. Formulating principles for practitioners to find useful, putting them into practice once understood theoretically, and identifying how to revise them based on experience gathered from real-life interventions, are all complicated tasks and yet lie at the heart of what DBR strives to achieve. The examples above show that researchers conducting DBR do not underestimate the agency involved when attempting to improve existing practices. The proposed model can scaffold the process of formulating principles, especially by stressing the importance of the procedural aspect, the need for identifiable criteria of success and reasons for relevance in a specific context. At the same time, the model can be used as an analytical tool when revising principles, where the five aspects can help focus the researchers’ redesign process. By putting more emphasis on how design principles not only become refined but also abandoned or completely rejected, DBR

researchers may be able to project a more realistic image of what it means to conduct DBR in response to messy real-life practice. Hopefully, this could contribute to not only more honest, but also more useful, educational research.

Conclusion

By proposing a model and analysing two empirical examples, we have identified possibilities and constraints when working with design principles in educational research and practice through DBR projects conducted in a Danish context. We argue that design principles should serve to guide the development and implementation of specific designs. This requires that researchers address the aspects of design principles presented in our model, as to why, who, what, how, when and which criteria apply to articulate, enact and evaluate the design principles. Furthermore, we argue that researchers should be able to articulate, enact and transform detailed design principles in iterative processes, and *also* be prepared for unexpected messiness that emerges when enacting design principles with respect for teachers' and students' agency. Thus, we argue that the continual articulation and adjustment of design principles should not only be seen as refinement, but also as a contingent process involving local agency, allowing unexpected challenges and valuable insights to emerge.

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