



Educational Design Research

Volume 10 | Issue 3 | 2026 | Article 113

Contribution Academic Article

Title **Communicating Design-based Research: A Framework for
Creating and Interpreting Educational Design Arguments**

Author **Pryce Davis**
University of Nottingham
United Kingdom

Christina Krist
Stanford University
United States of America

Daniel Rees Lewis
Northwestern University
United States of America

Abstract The goal of this paper is to improve how we compose and interpret educational design arguments from design-based research (DBR). Despite DBR's increase in popularity, ongoing discussions about its rigor, and detailed articulations of how to go about doing DBR, there is still a lack of specification when it comes to *communicating* DBR. We first explore some of the difficulties in communicating DBR and then describe a framework that helps provide guidance for creating and interpreting educational design arguments. Next, we demonstrate one application for this framework through a comparative analysis of several DBR papers and discuss how this framework allows both producers and consumers of design research to make sense of the products of educational design research, in particular educational design arguments. This framework helps the educational and learning sciences communities to mitigate challenges of communicating DBR by creating a more cohesive literature, helping researchers

plan and make decisions in the act of conducting and communicating their research, supporting training for less experienced researchers, and establishing a common standard lexicon for DBR communication.

Keywords design-based research; communication; methodologies; comparative analysis

DOI <https://doi.org/10.15460/d71ps057>

Citation Davis, P., Krist, C. & Rees Lewis, D. (2026). Communicating Design-based Research: A Framework for Creating and Interpreting Educational Design Arguments. *EDeR – Educational Design Research*, 10(3), 1-28.

<https://doi.org/10.15460/d71ps057>

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Communicating Design-based Research: A Framework for Creating and Interpreting Educational Design Arguments

Pryce Davis, Christina Krist, Daniel Rees Lewis

1.0 Framing the Problem

Over the past several decades, design-based research (DBR) has become a central methodological tool for the educational and learning sciences (Anderson & Shattuck, 2012; Barab, 2014). During this time, and continuing today, researchers have made strides in defining DBR in both its practice and philosophical underpinnings (e.g., Easterday, Rees Lewis, & Gerber, 2016; McKenney & Reeves, 2018; Sandoval, 2014). However, while the increase in popularity and discussions about rigor have begun the process of standardizing DBR as a methodology, there is still a lack of specification when it comes to *communicating* DBR. In other words, educational design researchers have moved from defining what DBR is to detailed descriptions of how to do it, but we still struggle with how to talk about it. This is despite an increased call within the educational and learning sciences for well-articulated examinations of DBR, including its processes and outcomes, both positive and negative (Kali, 2016; Svihla & Reeve, 2016). To increase the impact of DBR studies, we need more specification in how researchers compose, encode, and transmit descriptions of their DBR projects and how the community receives, decodes, and interprets those descriptions (Edelson, 2006). Yet, the nature of DBR – its focus on iteration, its recursive nesting of multiple data collection techniques, and its atypical products – make it difficult to communicate within the constraints of traditional academic articles. To make decisions about “what works” (for whom and under what conditions) from a highly contextualized methodology, we need the ability to unpack the logic of the study and pull out key pieces of information, like the specific learning theories, contextual demands, design principles, and research methods. We then need to understand how these details align with one another to form an *educational design argument*, a logically reasoned message describing and justifying how people should learn and how individual designs support learning.

The main goal of this paper is to improve how we communicate educational design arguments, both as consumers and producers of DBR. To that end, we present a framework for interpreting and creating educational design arguments. This framework has been developed over the past fifteen years, drawing on our combined experience of more than 40 years conducting and teaching DBR, conversations with other learning scientists, and discussions with participants at an *International Conference of the Learning Sciences* (ICLS) workshop (Davis et al., 2020). This framework explains the fundamental components of an

educational design argument and offers a structured and digestible way of understanding the logical relationships between these components. In this article, we first contextualize our framework by examining the challenges of communicating DBR in detail. Next, we describe the framework and how its various elements logically relate to one another. Following a description of this framework, we employ it in a comparative case analysis by deconstructing the educational design arguments of the six most recent (2021–2025) recipients of the Best Design Paper award from the *Annual Meeting of the International Society of the Learning Sciences*. We use the analysis of these texts to demonstrate the framework’s use in understanding the strengths and weaknesses of DBR communication, supporting researchers to develop skills as both consumers and producers of design research, and working towards a shared approach to DBR communication that allows educational and learning scientists to more quickly understand DBR contributions.

1.1 Challenges to Communicating DBR

A decade ago, Kali (2016) urged learning design researchers to clearly articulate the *entire research process* rather than focusing solely on the “successes” and to include “the non-linear, often surprising and sometimes frustrating process of design research.” While there have been increased attempts to discuss these processes (Svihla & Reeve, 2016), there has been little focus on how to effectively and consistently communicate DBR.

This is a serious need as there are major challenges to effectively communicating DBR. First, the varying scales and stages of DBR mean individual descriptions of research do not necessarily capture the breadth of the research. In DBR projects there is “too much story to tell” (McKenney & Reeves, 2018, p. 201). The iterative nature of DBR results in write-ups that (necessarily) focus on a small portion of the research – sometimes one or two iterations, but rarely more than that. In addition, the emphasis in publications can often only be on one aspect: the theoretical developments, the impact of the intervention on learning outcomes, or the nature of the design (and possibly its iterations) itself. Unless researchers turn to alternative modes outside of academic journal articles (McKenney & Reeves, 2018), this results in a fragmented literature, requiring putting together multiple papers, each framed to make a unique contribution, in order to “grasp” (and then evaluate) the full impact and use of the methodology. To compensate for this fragmented literature, it would be useful for the field to have a shared tool that allows readers to quickly and easily unpack research papers to see what is being prioritized and downplayed, and for researchers, in a given paper, to openly express what they have and have not decided to communicate from their larger “stories” and why.

Second, in communicating the complex processes and products of DBR, researchers must describe a multitude of aspects of their projects and the logical connections between these aspects. We refer to these

logically reasoned messages describing and justifying how people should learn and how designs support learning as *educational design arguments*. The term *design argument* has been used previously in design research, both in the educational and learning sciences and design studies literatures. In the latter, it is often used to describe efforts to communicate ideas about designs – constraints, requirements, goals, etc. – at the conversational level (e.g., Lee, Eastman, & Zimring, 2003), while in the former it has been used to describe more formal communication used to present a justifiable case for a particular design intervention, including “the features of a design necessary to promote a desired learning effect in a given context” (Easterday et al., 2016, p. 133; cf. van den Akker, 1999). We adopt the phrase *educational design argument* to expand on the former while differentiating from the latter.

Attending to the contents of educational design arguments in DBR is important because what sets DBR apart from other interventionist methods in education research, such as evaluation studies, is that DBR “opens up” the black box of the intervention and the processes by which it impacts learning by reporting complex interactions that both illuminate process insights while demonstrating local outcomes (Barab, 2014). The work of “opening up” the black box of learning processes involves answering questions that address the alignment between learning theory, the design principles and specific design instantiations of a learning environment, and the empirical analyses conducted about that environment (Figure 1).

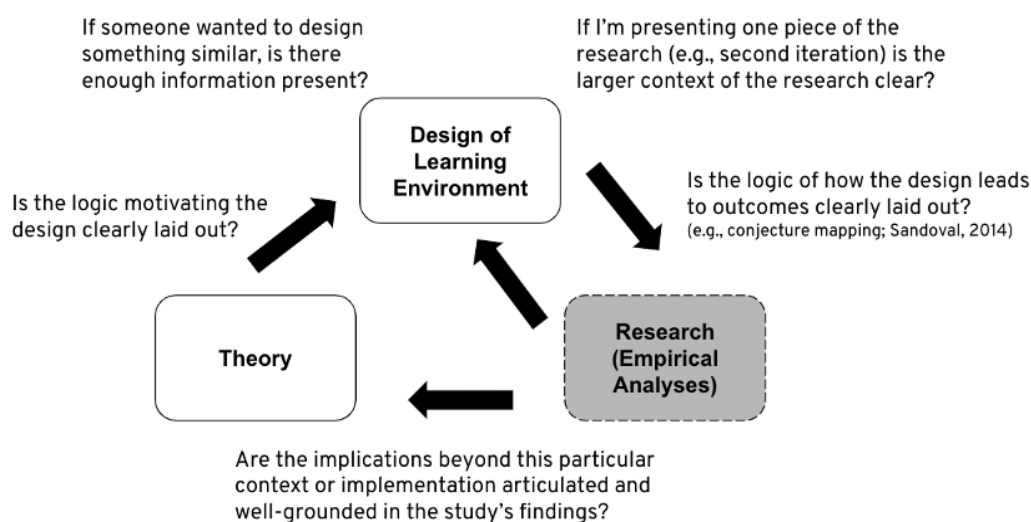


Figure 1: Implicit question in the logic of educational design arguments

However, there is no comprehensive approach to presenting educational design arguments. The approaches that have been proposed in the literature (e.g., Boling, 2010; van den Akker, 1999; Sandoval, 2014) each cover only some aspects of the logic needed to make strong educational design arguments. For example, Sandoval’s (2014) *conjecture mapping* is a very useful tool for explicating the alignment between theoretical perspectives and design commitments; but this

alignment is only part of an educational design argument and leaves out how to derive prescriptive conjectures from broader descriptive theory (Prediger, 2024), specify contextualize needs, or provide details about researcher actions and implementations. Likewise, Boling's (2010) *design cases* are descriptions of real artifacts and experiences and an account of their design and implementation, including explanations of changes to the design during these processes. These are excellent at providing forthright narratives of design processes and how decisions are made in the messiness of real-world enactment, but they place less emphasis on the underlying theory and empirical analysis that are definitional aspects of DBR.

We are not saying that conjecture maps or design cases are not good ways to communicate designs; we have used and will use both approaches based on the needs of our design processes and acts of communication. Instead, we are saying that the logic of educational design arguments within DBR include more aspects than either of these present on their own. We argue this is the reason we need a general, agreed-upon communicative DBR framework: A lot of design communication leaves some aspects of the argument implicit. These arguments are often piecemeal or fractured and are therefore difficult to interpret or judge. Furthermore, the lack of clear communication of educational design arguments leads to undertheorized DBR and, ultimately, to low-quality research.

Third, the lack of standard accounts for DBR results in major barriers of entry for new or less experienced writers and readers in both understanding communicated DBR and for learning how to conduct it themselves. Engaging in academic discourse requires an understanding of the specific genres employed by the community (Marshall, 1991; Swales, 1990), which in turn requires specific rhetorical skills. From a pedagogical perspective, new learning scientists require a heuristic to analyze DBR texts both as a means to judge them and to assist them in creating their own texts (Bruce, 2008). However, there has been very little work in defining conventions of DBR as a genre of academic writing, so less experienced readers and writers often struggle to understand and use the products of DBR. For example, from our experience, when working with graduate students on DBR projects, students frequently have difficulty using current DBR papers to inform their activities when they attempt to apply the frameworks or findings beyond the strict context of the work being presented in the papers. Descriptions of educational design arguments used to organize research (e.g., van den Akker, 1999; Sandoval, 2014) require a great deal of experience to properly implement and novice design researchers find such tools difficult to use to inform their own projects or judge arguments they find in the research literature. Furthermore, although DBR is a core method taught in a majority of learning sciences academic programs, DBR training is not available to students in all programs (Sommerhoff et al., 2018) and there is a lack of tools to help guide new learning scientists' understanding of DBR.

Finally, the lack of standard accounts also leads to issues in convincing key stakeholders of the value of DBR. Research domains with fewer agreed-upon standards, or paradigmatic development, are likely to receive less funding and have less impact upon policy, as the potential benefits of a novel methodology might be unclear to funders and policy makers (Pfeffer, 1993). For example, Edelson (2006) complains that a lack of methodological clarity in DBR makes it less fundable and harder to know what a “good” proposal looks like. Recently, McKenney and Reeves proposed a checklist for writing DBR funding proposals (2018, p. 198), which provides a useful way to identify the components of such proposals. We seek to build upon this work to provide a framework which helps analyze and communicate educational design arguments, the theoretical products of DBR.

Taking all of this together, we argue for the need for a standard way of *evaluating* DBR proposals, methods, and findings, and *presenting* them such that they can be evaluated. By this, we do not mean that we need to invent a new mode of communication or a schema for presenting design research into conventional publication standards (e.g., Gregor & Hevner, 2013). Instead, we are advocating for a shared understanding of the expected contents of an educational design argument within DBR so that we know, in the words of Swale (1990), “what is sayable and how and when it is sayable” (p. 88), no matter the genre of communication. Therefore, this paper offers a first step in coming together as a community to understand and improve how we communicate one of the key methodologies of our discipline.

In this paper, we present a framework for creating and interpreting educational design arguments that both producers and consumers of design research can use to make sense of the products of design research. This framework is meant to be flexible rather than dogmatic or prescriptive. It does not tell you how to do DBR or provide a template that an educational design argument must strictly follow. Instead, it provides a skeleton for researchers to make and judge arguments about designs for learning as they think through the different elements of a DBR project and the relationship between these elements. We believe that this framework – developed through our own and others’ expertise on conducting and teaching DBR – can be used as a methodological, evaluative, and pedagogic tool for learning sciences and educational researchers, teachers, and students.

2.0 A Framework for Creating and Interpreting Educational Design Arguments

2.1 Using the Framework

Before we turn to the description of its components, we need to make a few things explicit about using the framework. This framework is derived from a broad selection of existing thoughts on DBR, so its scope is broad as well. We see it as flexible enough to help illuminate educational design arguments – their creation and interpretation – from any educational DBR tradition, presentation mode, or publication format. With that scope in mind, we want to make clear that this framework is a tool for finding or adding coherence in educational design arguments. There are a multitude of ways to present DBR and arguments for designs for learning, and we are not dictating a particular approach. We embrace any way or form of communicating DBR. This framework is best thought of as a background tool for checking whether the arguments embedded in communications are clear and coherent. Likewise, our framework is not a process diagram or a rigid “how-to” guide for DBR. Instead, the framework offers a simple structure for thinking about the relationships between components when creating or evaluating a DBR argument. Accordingly, there is not necessarily a “starting point.” Researchers may find it useful to first articulate one component before another; there is no set route to take when creating or interpreting educational design arguments. The framework only suggests an “order” or “direction” in the argumentative logic. Furthermore, various studies and their write-ups focus on different components: A single study does not necessarily interrogate each component. So, evaluating such arguments will necessarily reveal that some components are more articulated than others. The point is to help us recognize what is present and what is missing in communicated educational design arguments, and how we can improve this communication going forward.

Accordingly, we view outcomes of this paper to be three main applications of this framework:

- (1) *Research.* The first outcome is the development of a flexible and shareable structure for linking theory and design to produce usable knowledge. This begins the process of standardizing the presentation of educational design arguments in academic write-ups. It also fleshes out the “big picture” of DBR, so that even if a particular article or presentation focuses on a single aspect or iteration, the larger context of the DBR is still clear and explicitly communicated.
- (2) *Design.* The second outcome is a refinement in the way we make design decisions. It illuminates how existing design frameworks/processes “fit” into DBR. It also provides explicit delineation between various aspects of the research/design cycle,

so that the alignment between design and theory is distinct and connected.

- (3) *Evaluation*. The final outcome is providing a way to analyze educational design arguments (proposing and then answering meaningful questions about designing for learning), and a way to unpack assumptions in the design (and study design) process. This can actually help multiple audiences: training novice learning scientists on how to analyze and unpack DBR; helping learning scientists more quickly communicate/avoid reinventing the wheel; helping teachers understand the messages they receive about using certain educational innovations, tools, or technologies in their classrooms; providing support for parents/teachers/administrators etc. attempting to appraise commercially available learning technologies; and offering tools for other stakeholders (e.g. funders) to evaluate proposed DBR studies and assess their products.

In the following section, we offer a breakdown and unpacking of the key aspects of the proposed framework, the relationship between these aspects, and how they function in communicating a holistic educational design argument.

2.2 Description of Framework

This framework (Figure 2) consists of eight components – six main components, two of which are further broken down into additional four sub-components each – of an educational design argument that DBR ultimately needs to communicate. In discussing DBR output, there is a natural overlap between these components. For example, descriptions of fundamental assumptions about learning that serve as the theoretical background of a piece of research may lump together many ideas that appear to have similar discursive functions in a broad sense but lack clarity at a level of granularity required for someone to unpack and understand the educational design argument. Our goal here is to make clear the distinctions of each component of an educational design argument within DBR so that the *logic of the relationships between each component* is made clear and digestible. In other words, simply including these eight components in a presentation of an educational design argument is not enough. Creating or interpreting an educational design argument needs to attend to the alignment between components: Does one logically follow from another in a sensible way?

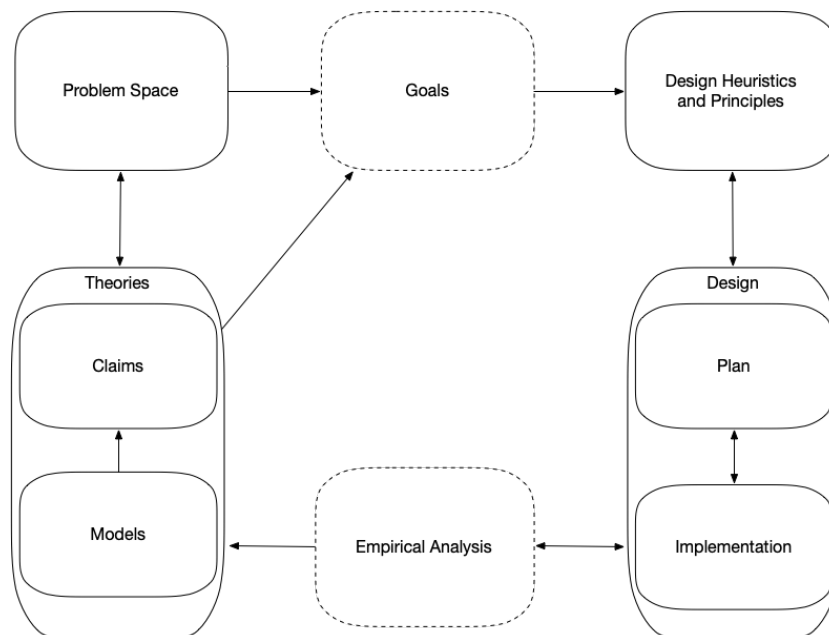


Figure 2: Framework for creating and interpreting educational design arguments

With this in mind, we will now describe the components of the framework and their relationship to one another. As previously mentioned, there is no true starting point in the framework, but we begin our description in the lower left corner, which is what is generally called *theory*. We begin here as prior research and feedback from peers and students has told us that understanding how to derive design from theory and theory from design is difficult to grasp initially.

2.2.1 Theories

DBR is meant to be theory-driven and theory-producing (Brown, 1992; Design-Based Research Collective, 2003). Like any scientific endeavor, theories are important for educational and learning sciences to guide researchers toward generalized understanding of phenomena of interest, including the broad and still contested mechanisms of how people learn, and offer frameworks to suggest what aspects of a phenomena are potentially fruitful for research to contribute towards that broad understanding. Appreciation of the concept of *theory* and how it is both an underpinning and outcome of research is a major challenge in learning to become a researcher (Kiley, 2015). *Theory* is used variously to refer to constructs that are explanatory, descriptive, predictive, prescriptive, and/or foundational, depending on the domain, field, or level of formality of use. DBR in educational and learning sciences draws on a wide range of interdisciplinary theory. Obviously, a major contributor is *learning theory* or various levels of theory related to learning, how people learn, and how to design for learning. However, our framework uses the broader designation of *theories* for this element of educational design arguments to acknowledge and leave room for the application of theories not directly related to learning (e.g., theories of socialization,

development, communication, organizational change, media interactions, etc.). The theoretical products of DBR often focus on local and practical theories that take the form of *humble* descriptions of domain- or context-specific learning (Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003) and not “grand” theories that are too broad to suggest anything specific about design. However, the larger field is still often oriented around such broad theories or philosophical positions – such as constructivist or socio-cultural perspectives – and descriptions of DBR studies often fail to make it clear how they move from the “grand” theory to the “practical”.

To address this, we make this shift explicit in our framework by making a distinction between what we call *models* and *claims*. The choice to make this distinction in theory within our framework should become clear as we discuss it, but we would like to note that, in practice, this distinction is often less discrete in DBR communication than we are arguing it should be. The categorization of theory as either model or claim rests on its use within the educational design argument as either *descriptive* or *prescriptive* rather than various definitions for “theoretical models” and “knowledge claims” found in scientific discourse and epistemology. Many ideas that we might call “theories” are rife in educational design arguments, both explicitly and implicitly. As Cobb et al. (2003) point out, theories in design studies might be used as “grand” theories previously mentioned that are the broad universal and accepted conjectures like those found in the physical sciences. So, something like Piaget's theory of intellectual development is often treated similarly in educational research to the Modern Evolutionary Synthesis in biological sciences. Likewise, theory can be used as orienting frameworks that communicate commitments to specific families of related ideas that describe how learning happens (e.g., “constructivism” or “socio-cultural”). We are not here to argue the validity of this use, but rather to understand that theory can and is used this way, and to highlight its presence in communication of DBR. We would label both “grand” theories and orienting frameworks as *models* within educational design arguments as they both offer underlying *descriptive* representations of the phenomena of interest and position the design toward particular perspectives and associated assumptions. Therefore, our framework defines *models* as generalized descriptions of how target processes, for example learning or motivation, happen in the real world as derived from empirical evidence. For those creating educational design arguments, clearly communicating the *model* that underpins the research serves as a first level of orientating your audience to your perspectives. For those interpreting educational design arguments, teasing out the *model* – even when one is not explicitly stated – offers initial insight into the researcher's basic assumptions, perspectives, and framing.

Models as descriptive theories are important for educational design arguments, but they require a logical turn towards action and prescription to effectively motivate designs. The types of theories we refer to as *claims* in our framework are where broad theoretical descriptions (models) become prescriptions about what should take place and thus local and practical. As models are broadly descriptive, claims are broadly prescriptive. They are specific assertions or conjectures about how to make learning (or whatever target

phenomenon) happen derived from the models and informed by the demarcation of the problem space (see below) under consideration.

Claims might include things like what Cobb et al. (2003) call frames of action – “more or less general prescriptions of pedagogical strategies” or domain-specific instructional theories (p. 81–82). Likewise, claims might include theoretical prescriptions not directly related to arguments about learning, but which inform the design nonetheless, often due to the contextual demands of the problem space. For example, critical theory is not directly a “learning theory” but might be used as a model in an educational design argument as it describes perspectives related to systemic power, whereas critical pedagogy turns those descriptions into prescriptions for education as a means of emancipation and social justice and so could function as a claim. The point here is that DBR can draw from a variety of theoretical perspectives and intellectual traditions, so our framework does not dictate what “counts” as theory, but rather how these ideas are used descriptively and prescriptively to ground design conjectures.

Another way of viewing theoretical models and claims is that together they form a sort of conditional logic: IF the *model*, THEN the *claim*. A clear example of this relationship can be seen in Papert’s constructionism (Papert & Harel, 1991), which is derived from the model of constructivism that we can summarize as: Learning is the construction of new knowledge from experience and social interaction being integrated with existing knowledge. Constructionism then is the claim that: [If we accept the model of constructivism], then learning happens particularly well in contexts where learners actively and consciously construct meaningful products based on their knowledge. This claim serves two functions: 1) It narrows the focus from broad, difficult to apply theories to an intermediate scope that is better able to guide design (Cobb, et al., 2003); and 2) it transforms the description of learning into a prescription for how to support learning.

In practice, this transformation from description to prescription does not always explicitly take place in DBR communications. Instead, this turn is frequently implicit, resulting in an “is-ought” problem (Hume, 1739/2003): a logical fallacy that muddles the distinction between prescription and description. Hume argues that we cannot derive prescriptions for how things ought to be based only on descriptions about the way things are. In educational and learning sciences, too often we treat descriptions and prescriptions as the same. For example, observing that students are more motivated after receiving fruit snacks for completing a task should not automatically lead to a design prescription that students should receive fruit snacks for completing any learning task. In a less silly example, a university course learning outcome of “students will actively construct knowledge” does not properly function as a prescription because it is simply a description of how learning works (i.e., constructivism). It does not offer any kind of action based on that description, whereas goals like “learners will construct meaningful products based on personal interests” or “teachers will scaffold expert problem solving through modelling and coaching” are more reasonable as they are derived from prescriptive theory derived from descriptive theory (i.e., constructionism and cognitive apprenticeship, respectively).

In DBR, this “is-ought” problem causes confusion about how designs are drawn from theory. Perhaps this is due to researchers wanting to avoid the appearance of being subjective or value-laden. However, DBR research necessarily engages in value judgements and making this “is-ought” turn apparent provides clarity to the theory being used and how it specifically motivates design decisions. Finding this “is-ought” turn in published DBR is often quite difficult and requires careful reading or even rephrasing of the text to fully express the claims as prescriptive and make the foundational logic clear.

2.2.2 Problem space

The next component in the framework is where the argument defines and motivates the *problem space* (Dorst, 2004), which elucidates the target population, details and demands of the context, and the specific needs being addressed (essentially, the things that are typically explored in traditional needs analysis in curriculum design, e.g., Nunan, 1988). The articulation of the problem space should spell out the specific problems that need to be addressed. Therefore, they have a bi-directional relationship with *claims* that must demonstrate alignment. Without clearly articulating the problem space, the claims are meaningless as they lack context and grounding. Conversely, examining a problem space without reference to descriptive and prescriptive theory makes assumptions unclear and unmoored from prior research.

Issues arise when problem spaces are expressed at the inappropriate grain size. A researcher can talk about large-scale problems that might be addressed through their comprehensive, multi-iteration DBR sequence, but fail to specify the smaller-scale problems that can be addressed in a report about a single DBR study of one or two iterations. For example, a lack of scientific literacy in middle school students is too large-scale a problem unable to be comprehensively addressed in a single DBR study (or even a project). However, identifying the challenges students encounter in linking evidence to claims from investigations is a smaller-scale learning problem that DBR researchers could meaningfully tackle in one DBR study. Again, this is about aligning the problem space to the rest of the components, so the educational design argument is clear and accessible.

Related to expressing the problem space at the appropriate grain size is making sure you consider the contextual demands, both cognitive and socio-cultural, that make the problem a “problem” in the first place. By definition, DBR takes place in real-world contexts. So even if the design goals are focused on, for example, improving specific cognitive functions, researchers still need to ground the problems in broader aspects of the context to more clearly delineate variables. One common issue is research that frames challenges as deficits or gap-gazing problems (e.g., Black students have lower 8th grade science scores than their White and Asian counterparts). These are communicated as simple problems, but this hides the root causes or contributing factors, which are often institutional or societal. Moreover, the same problem space for a design manifests in many contexts, and the contextual variation may lead to different design

solutions. For example, teachers participating in a professional development workshop on curricular customization as a school-based team vs. as independent tutors from across multiple schools or districts are likely brought together to address different problems of teacher learning: that of needing to build collective capacity for understanding and grappling with the particular conditions of one's teaching context vs. that of needing to develop broad strategies or principles for customization that may be transferable across contexts. In other words, a problem definition of "teachers need to customize standardized curriculum materials to their contexts" would be better communicated with a specificity that takes the contextual demands into account. It is better to be explicit about the contextual demands that constitute the "problem" and focus design solutions at an achievable level.

2.2.3 Goals

The next component of the framework is the *goals*. Simply put, goals are the desired outcomes of the design based on a synthesis of the *claims* and in response to the needs and demands set out in the *problem space*. We again use a broad category to leave freedom for individual cases, but generally speaking, *goals* would include learning goals or objectives (like those common to instructional design, e.g., "the student will be able to explain the particulate nature of matter"), but also objectives that are not directly related to learning but are derived from the contextual demands (e.g., "fostering a safe space of students to express their identities) or conjectures about intermediate and intervention outcomes of the design (Sandoval, 2004). While this may seem obvious – you must communicate what you want to achieve –, it is easy to find examples of educational design arguments with goals that ignore either the underlying theory or problems and needs to be addressed. Commercial learning products are often guilty of this by communicating ill-defined claims about learning (often derived from limited research or a narrow understanding of theory) and positing their products effective in addressing imprecise learning problems or needs. Of course, that is not unexpected since the point of communication about commercial design is often sales and marketing where some things might be purposefully vague while others overemphasized. However, descriptions of design where the relationship between goals and underlying theory and problems is fairly implicit can also be found in the DBR literature. This is often due to the way communication of DBR is structured. For example, Horn, Davis, Banerjee, & Stevens (2020) present a DBR *design case* (discussed above) for a family board game focused on home energy use. The authors state clear goals of the design in the introduction that we can paraphrase as: to encourage whole families to reflect on household energy consumption and the day-to-day practices involved in managing household energy systems. However, finding how this goal is derived from the narrative of the design process requires the reader to do some unpacking. During the design narrative, the authors

briefly describe the theoretical perspective (model) they adopt as one that views learning as a process through which “value systems, personal identity, and practices of a community shift over time as new participants take on meaningful roles” (p. 118). They then explain that, based on this model and their empirical research, modern home energy practices suffer from specific challenges that make it difficult for new participants, i.e., children, to develop competency. So, here we have clearly stated theory (the model related to perspectives of learning for and through cultural practices) and problem space (the outlined challenges). However, the claims that connect the model and problem space and how the goals were derived are less explicit. For example, one of the stated challenges is the diminished visibility of practices for home energy management. Based on this the authors describe their design decisions and how they settled on an approach that leverages highly visible, existing family practices to scaffold family home energy management. They state this without directly explaining how this approach became the goal of the design, but applying our framework helps readers recognize these nuances to understand the complete educational design argument.

2.2.4 Design heuristics and principles

We move to the right-hand side of the framework that represents the design itself. The first component to discuss here is the *design heuristics and principles*. Many scholars have discussed the nature and use of design principles (e.g., Easterday et al., 2016; Euler, 2017; Feulner, Rosendahl, & Serwene, 2026; Leonard, Fitzgerald, Kohlhagen, & Johnson, 2017) and we do not think it is necessary to rehash this literature at length. For our purpose we define *design principles* as propositions that prescribe general strategies for achieving the stated goals. The importance of clearly articulated design principles is that they function as the fulcrum on which abstract theory becomes manifested in concrete design and they provide an apparatus for empirical investigation. This description echoes Euler’s (2017) characterization of design principles as the hinge between theoretical and empirical knowledge production – which we argue is what the previous aspects have described – and the basis for designing practical action to achieve the goals.

Euler (2017) also describes in detail a process by which design principles are derived. Again, we do not think it is necessary to rehash that process here, except to say that we add the extra description of *design heuristics* to cover communication of early stages of DBR projects when ideas and prescriptive design statements are being initially generated and negotiated through testing and formative evaluation. It seems wise to describe these proto-principles or inchoate approximations as heuristics and include them as elements to be communications.

When crafting design principles – both methodologically and communicatively – it is important that they are clear, distinct, and at the

proper grain size. This last point is crucial as design principles should be applicable for multiple designs and not wholly tied to the individual design under discussion, and yet not so general that they ignore the contextual demands. This is tricky, but it is necessary for a functional DBR study. The contextualized nature of DBR means that it does not replicate in the traditional experimental sense. However, if design principles are clearly communicated, then later researchers can test their usefulness and validity by using those principles as the foundation for new designs. Of course, these new designs are likely to be in (at least slightly) different contexts, so new appropriate principles may be added to the framework. After all, DBR should neither aim to create one-size-fits-all nor individually tailored products.

2.2.5 Design

The next element of the framework is the *design*, that is, the description of the particular intervention that is an instantiation of the design heuristics or principles to address the goals (i.e., the design as noun, not verb). Just as we earlier split *theories* into *models* and *claims* to delineate their functions in DBR, and the communication thereof, we also split *design* into distinct descriptions of the *design plan* and the *design implementation*. The *design plan* is a description of the blueprint of a design of a particular learning tool derived directly from the design principles, but often before implementation. By “blueprint” we mean to highlight that this is the formulation for the stage of the design that is being presented in the particular write-up (Easterday et al., 2016). So, the *design plan* is the result of whatever brainstorming, prototyping, implementations, and iterations that have taken place before this localized description of the DBR. This requires some narrative about how this *design plan* came about and its place in the broader research agenda. Likewise, the researcher needs to fully communicate how this blueprint is derived from the design principles. Where many write-ups fail is by either under-describing the design, describing a stage of the design that is not immediately relevant to the particular study under discussion, or failing to draw a clear line between the design principles and how they are instantiated in the design plan. Sandoval’s (2014) conjecture mapping is a helpful approach for addressing this common disconnect.

If the *design plan* is akin to a blueprint, the *design implementation* is an explanation of what happened and, crucially, what changed in the design during its enactment in real-world settings. In most educational design arguments, the description of the *design implementation* is usually either folded into a general description of the design or ignored. In other words, the design plan and design implementation are treated as the same general *final form* design description (Svihla & Reeve, 2016). However, it is important to communicate the interstice between what was planned and what actually happened during implementation. No design is 100% faithfully implemented into real-world situations – implementation introduces messy new variables and the results of decisions about how to implement, whether made by the researcher or another actor (like a teacher), in some way alter

the design. These may be major or minor alterations, but it is still important to describe the learning intervention *as it was actually enacted*. What happens in this interstitial space directly affects what conclusions can be drawn from the research. Being transparent about how implementation affects the design helps researchers guard against telling just-so stories that show a pristine line from theory to design to empirical conclusions with little room for scrutiny and discussion. Communicating the *design implementation* also again helps differentiate where in the “big story” of the research the individual study lives. This is the strength of design cases as a mode of communicating DBR; but even when adopting depictions less tailored for this purpose, it is essential for the maintenance of high-quality research that this distinction or interplay between plan and implementation is made clear.

2.2.6 Empirical analyses of learning

The final component of the framework is *empirical analyses of learning*, which are descriptions of studies of the designed learning tool in the real world. These empirical analyses produce evaluations of the design, refinement of principles, and/or new or modified theoretical models/claims. We note that this framework is agnostic towards the particular methods of data collection or analysis used in a given study. DBR is stronger for the diversity of its approaches to empirical investigation of designs. In communicating the results of empirical analyses, we defer to the existing work within the educational and learning sciences and related fields that propose the standards for communicating the empirical analysis of any given method. A helpful addendum can be to make sure that the empirical analyses employed intentionally put the theories, models, or design principles at risk and that the empirical data collected allows the researcher to evaluate whether and how the design principles effectively accomplished the design goal. In other words, DBR seeks to empirically test and support design conjectures as the hypothesis in question.

In addition, an aspect of communicating empirical results that is particular to DBR studies is ensuring that the chosen methods align with every other part of the framework, and that any non-alignment is explained. For example, if the problem space specifically references classrooms, then the empirical analysis should, logically, take place in classrooms. One exception is descriptions of analysis before full implementation, such as expert review or testing of prototypes. However, generally speaking, an educational design argument should include the particular focus of the analysis, how conclusions are drawn from the analysis, and how these conclusions feed back into theory; and all need to be logically aligned and clearly communicated.

3.0 Putting the Framework to the Test: Comparing Educational Design Arguments

Now that we have described our proposed framework, we will illustrate a way to apply and use the framework in a comparative analysis of the educational design arguments presented in a selection of research papers. Our goal in this analysis is to use our framework as an evaluative tool (as mentioned above in the “using the framework” section) to examine how a selection of papers present their educational design arguments to demonstrate the challenges of communicating DBR and the utility of our framework as a deconstructive tool. Before we begin our analysis, we outline our methodology.

3.1 Methodology

3.1.1 Paper sample selection

As this analysis is meant to be illustrative of the utility of our framework for deconstructing educational design arguments, we wanted our sample of papers to contain design arguments that have already been considered high quality by the educational and learning sciences community. Sampling papers pre-judged as high quality allows us to demonstrate that even good educational design arguments may attend to some components of our framework more than others. This choice also helps us to not get mired in the sort of condemnatory or contentious rhetoric that would accompany the analysis of arguments considered “bad” – we want this work to be positive and useful, and we are not trying to pick fights with following researchers. Additionally, we wanted to sample works that allow our analysis to be brief but with enough depth for our evaluative purpose. Therefore, to meet our criteria of relatively short papers with high quality educational design arguments, our sample of papers are the six most recent winners of the Best Design Paper award at the Annual Meeting of the International Society of the Learning Sciences (ISLS) – Agesilaou & Kyza (2021), Nathan, Walkington, & Swart (2022), Lawrence et al. (2022), Zhou, Pullen, Holmes, & Slotta (2023), McClure et al. (2024), and Green & Pinkard (2025). Sharma et al., 2021, was also a Best Design Paper winner; however, this work presents an argument for new measures within eye tracking methodology rather than educational design research as we understand it.

This selection is drawn from the period since the bi-annual International Conference of the Learning Sciences (ICLS) and the International Conference on Computer-Supported Collaborative Learning (CSCL) were combined into one annual meeting (2021–2025). This period was selected as a useful limiting factor for the number of samples and for convenience as the record of paper awards for this period is easy to locate. For context, the Best Design Paper award is given each year (along with awards such as Best Paper and Best Student Paper) to, as the name suggests, papers that present educational designs, frequently through design-based research, that are deemed the highest quality. However, there is not an exact standard for this award, and it varies year-to-year based on the make-

up of conference organizing committees, even sometimes giving an award for each of the two programs within ISLS (ICLS and CSCL). The changing standards mean there is enough variation in papers to uncover useful comparisons in how they present their educational design arguments. We also note that our analysis is not meant to pass judgement or critique the research presented in these papers nor the decisions made by the awarding committees. We agree that these are high quality pieces of work, worthy of their awards; our aim is to understand *how* they present their educational design arguments.

3.1.2 Analytical approach

The process of our comparative analysis is quite straightforward. The first two authors independently performed content analysis through close readings of the six focal papers for both manifest and latent meaning of components presented in the texts. The goal was to unpack the educational design argument of each paper by locating each component of our framework within the text, either explicitly through direct interpretation or implicitly through inference. Essentially, our framework acted as a deductive, top-down coding scheme for the analysis of the text, whereby we first categorized the presence of each component and then made interpretative judgement of how explicitly and clearly each component is communicated in the papers. We then brought the two independent codings together for review of any disagreements. While there were no overt disagreements, our discussion led to additional differentiation between when a component is explicitly present but unclearly communicated in the text versus when a component is implicit in the text, the former meaning it is directly stated but lacking in detail and the latter meaning it is merely suggested without direct statement. The third author acted as a final check on the agreed coding of the selected papers.

We have organized the results of our analysis into a table with rows representing each framework component and columns representing each focal paper to display the results of our analysis as an easy-to-view matrix (Table 1). The codes related to the presence of each framework component in each paper are presented as a grey scale: black = explicit, dark grey = present but unclear, light gray = implicit, and white = not present. We then each noted observations about similarities and differences across the focal papers for each component, noting general patterns and outliers that grabbed our attention. Finally, we synthesized our observations and interpreted them within their context and the broader DBR literature to produce themes, which we now present as the results of our analysis.

Table 1: Four-scale coding of framework components in sample papers

	Model	Claim	Problem space	Goals	Design heuristics/principles	Plan	Implementation	Empirical analysis
Agesilaou & Kyza (2021)								
Nathan et al. (2022)								
Lawrence et al. (2022)								
Zhou et al. (2023)								
McClure et al. (2024)								
Green & Pinkard (2025)								

3.2 Results of comparative analysis of educational design arguments

We next present a summary of how each framework element showed up (or not) in each of the analyzed papers. The point is to help us recognize what is present and what is missing in communicated educational design arguments, and how we can improve this communication going forward. For this reason, we organize this section themes across framework elements, and not by paper, in order to foreground tendencies, variations, and strong examples of each type of element that can support scholars in deciding how to communicate each element of their own studies.

3.2.1 Focus on claims more than models

In describing above how our framework treats theory in educational design arguments, we mentioned the issue of DBR frequently creating “is-ought” problems by not adequately communicating the logical move from descriptive (models) to prescriptive (claims) theory. This tendency is clear in our analysis when comparing how these papers treated claims versus models. All of the papers communicate either explicit, or present but not entirely clear, prescriptive theoretical claims. However, when communicating descriptive theoretical models, two have models that are implicit and require inference on the part of the reader (Agesilaou & Kyza, 2021; McClure et al., 2024);

two have models present but which are very broad (Lawrence et al., 2022; Zhou et al. (2023); and only two have specific explicit well-defined models (Nathan et al., 2022; Green & Pinkard, 2025).

This variation in the explicitness of claims rather than models across these papers could be interpreted in a few ways. It could be indicative of broad trends in design research prioritising frames of action (Cobb et al., 2003), theoretically grounding designs as frames of action give direct guidance for design and lend themselves better to empirical scrutiny (i.e., they are “humble” enough to be tested). However, this observation could also be explained by the nature of the medium of communication. Conference papers (even “long” papers) are quite restricted in length and require shortcuts in communication. The authors may trim descriptions of underlying, descriptive theory for a number of reasons, including assumptions that the audience will know or infer theory due to shared understanding within the ISLS community and the need to move quickly into the prescriptions to motivate the goals and design descriptions. Our analysis cannot conclude which is the correct interpretation. Instead, we note that some of these papers could improve how clearly they express the shift from descriptive to prescriptive theories in order to strengthen the theoretical contribution of their research. Given the growing size and diversity of intellectual and theoretical traditional presentation in educational design research suggests a need to question assumptions about shared background knowledge and expectations. That said, it is commendable that these papers present as many specific, testable theories as they do as moving from abstract to actionable theory to testable is a difficult but necessary part of creating educational design arguments.

3.2.2 Articulation of problem space and goals over design heuristics or principles

Our analysis showed two patterns in the relationship between the articulation of problem space, goals, and design heuristics and principles within these papers. First, all of the papers presented clear and strong articulation of problem space. It is clear that an emphasis in these communications is given to defining problems to motivate designs, which is not really surprising. Second, there was variation in the degree of specificity in both (a) the goals presented and (b) the design heuristics or principles presented. We will discuss each of these variations.

The variation in goals was in terms of broadness (generic, multiple possible pathways to achieve them) vs. specificity (tailored to a particular context or desired outcome such that the pathway to meeting itself required innovation). An example of broad goals is clearest in Nathan et al. (2022), which presents a robust problem space about the use of abstract symbol systems in disciplinary knowledge and the struggles students have with problem solving using such abstractions, but the broad goal of promoting mathematical proof solving practice. Having such a broad goal might seem odd, but it makes sense for this paper as it focuses on five empirical studies of theory building and testing around the design rather than an in-depth

focus on articulating the design itself. An example of specific goals is in Green & Pinkard (2025), who examine the design and implementation of an app, Freeze Frame, aimed to help “reveal socio-spatial patterns of youth engagement” in out-of-school time spaces (e.g., their routes home, libraries, shops, after school clubs). The specificity of their goal allowed them to then make specific design decisions about the app itself and how they worked with youth to collect data.

The articulation of design principles was another area of variance across these papers. While two of the papers (Agesilaou & Kyza, 2021; Nathan et al., 2022) specify clear design principles, the others either present a framing idea that could be considered a broad heuristic (e.g., Green & Pinkard, 2025; Zhou et al., 2023) or set of ideas (e.g., Lawrence, et al., 2025; McClure et al., 2024) that requires inference to be considered design principles. Design principles are important as testable and generalizable products of DBR (Easterday et al., 2016), and yet they take time to generate over the design research process (Euler, 2017). The observed variation in principles could reflect the various stages of design principles development of the broader research projects each paper presents. A lack of principles or focus on broad heuristics could imply early work that is presenting research on initial iterations of design, while robust design principles imply more mature work that is presenting synthesized findings from multiple iterations of design and research. Both contributions are valuable to the field and our framework helps bring these differences into the open.

3.2.3 Variation in amount of DBR process presented

The previous theme directly related to the theme of large variation across the papers in how much of the DBR process is being communicated. This variation is partially evidenced by the stark contrast between the near universally explicit descriptions of the design plan in each paper compared to varying levels of implicitness in the treatments of the design implementation. Two of the papers described multiple design iterations (Agesilaou & Kyza, 2021) or revisions (Lawrence et al., 2022) with some level of distinction made between initial plans and changes following implementation. Lawrence et al. (2022) uses design narratives and conjecture mapping to describe the development of their design through iteratively more real-world design sessions with specific attention given to what parts of the plans worked and did not work in each implementation. As mentioned, Nathan et al. (2022) described a synthesis of five studies of their design, so while iterations through implementation are suggested, the specific changes to design during or following implementations are left unclear. Green & Pinkard (2025) describe only one iteration and make no mention of adjustments. McClure et al. (2024) describe their work as a three-year DBR project but only present a case study of one implementation. Zhou et al. (2023) only describe the design plan as the design has not yet been implemented, which also explains why this is the only paper that lacks a description of empirical analysis as well. Of course, this makes sense as this paper is categorized as a “Technology Innovations” paper that just needs to

describe the goals, design principles, and description of a novel application of technology.

In general, there is a tendency across these papers to make little distinction between design plans and iterations and, thus, present *final form* descriptions (Svihla & Reeve, 2016). However, the individual presentation decisions in each paper make sense for where they are in the DBR process (e.g., number of iterations) and their objective in communicating their research given the limited space of a conference paper. We can quibble about whether each paper does enough to capture the reality of design decisions based on real-world implementation, but our point is that applying our framework helps tease apart whether, when, and how the design process is communicated through a focus on distinguishing between design plan and design implementation.

4.0 Discussion and Conclusions

In proposing this framework, we seek to help the educational and learning sciences communities mitigate four challenges of communicating DBR that we raised in this paper. First, the framework can help create a more cohesive learning sciences literature. As we noted above, DBR literature is fragmented because in each DBR project there is “too much story to tell” (McKenney & Reeves, 2018, p. 201). That is, because of the varying scales and stages of DBR, the full impact of the methodology cannot be found in any one paper. Rather, these stories must be pieced across by many papers from one DBR project, and the connections between these papers are rarely made explicit by the authors. The framework can mitigate this issue by helping researchers to acknowledge which parts of the framework they have left out and will address in future or past work. As such, the framework can help learning sciences researchers reading DBR literature keep track of different papers in larger DBR projects. Furthermore, the framework could make reviewing DBR papers more systematic, as reviewers could use the framework to analyze the success of DBR communication in submitted papers. Finally, DBR researchers might use the framework to push back on reviewers who ask for papers to be expanded far beyond the authors’ intended contribution. That is, DBR researchers might use the framework to reduce “mission creep” by more precisely stating their contribution in terms of the framework, including clearly noting what is out of scope for a given paper.

Second, the framework can help DBR researchers themselves to plan and make decisions in the act of conducting and communicating DBR projects. Because DBR projects contain so many stages and potential contributions, DBR researchers must take on the challenging tasks of planning both what to do and what to communicate. The framework can help DBR researchers choose what to explicitly communicate in a given paper. Having a standard framework of the components to communicate can help DBR researchers do so more quickly and effectively. Furthermore, the framework might help DBR researchers to think more clearly when planning in the midst of DBR. For example, by being explicit within the DBR team about the learning claims, the

goals, and the design as implemented, DBR researchers can make better decisions about what data to collect. As such, DBR researchers can avoid spending time and resources collecting data that does not directly address focal research questions. While we ourselves are qualitative researchers who understand the value of context and rich datasets, it is often the case that DBR studies result in an overabundance of data, the vast majority of which is either never analyzed or does not help make theoretical advancements in the learning sciences (Dede, 2004).

Third, the framework can support training for less experienced DBR researchers, such as graduate students or scholars from other research traditions. The lack of standard accounts for DBR, including the fragmented literature, results in major barriers of entry in terms of both deciphering communicated DBR and conducting their own research. By making all of the different elements of the design argument explicit, the framework can help less experienced DBR researchers to understand standards and know how to communicate their work. We believe that a framework stressing the connection between the many related components in a DBR project is particularly powerful as one of the core challenges to DBR practice is to integrate these different aspects of a project. In so doing, researchers new to DBR can avoid common pitfalls, such as engaging in entirely atheoretical projects which just focus on the design or on entirely theoretical projects with no design. As we noted above, we have applied the framework in our own teaching. In our experience, we have found that students are able to apply the framework to both more deeply interpret and discuss existing DBR papers and to support their own DBR communication.

Fourth, establishing a common standard lexicon for DBR communication can help the field receive greater support from policy makers and funders. Research domains with less paradigmatic development – that is, fewer agreed-upon methodological standards – are likely to receive less funding and have less impact upon policy (Pfeffer, 1993). The framework can help create clearer articulations of DBR products and projects for funders and policy makers. Ultimately, this can lead to better funding for DBR projects, as well as a greater uptake of DBR designs and ideas that support better learning and more equitable education systems. Furthermore, the framework could help policy makers be more critical consumers of DBR and educational design more generally. For example, the framework could help school district administrators analyze the claims of different learning technologies.

As discussed in Section 2.1, the scope of this framework is necessarily broad as the landscape of DBR is rich and growing. We believe that our framework is applicable across a wide range of DBR traditions and communicative modes. We argue for its benefits for research, design, teaching, and reviewing DBR projects. Ultimately, the framework can help the learning sciences DBR community have a greater positive impact on educational systems and the lives of learners.

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Author Profile

Pryce Davis is an Assistant Professor in Learning Sciences and member of the Learning Sciences Research Institute (LSRI) in the School of Education at the University of Nottingham. His research focuses on informal learning across contexts and lifespan, the public engagement with and meaning making of science and academic research, and the design of learning environments.

Christina Krist is an Associate Professor of Science Education and Learning Sciences at Stanford University's Graduate School of Education. Her research focuses on how science learning environments can be structured to support students' epistemic agency, sense of belonging, and authority as knowers, with particular attention to students and communities who are systematically marginalized in STEM.

Daniel Rees Lewis is a Researcher at Frontiers and the Human-Computer Interaction + Design Center at Northwestern University. His research focuses on the design of technologies and services for feedback, coaching, planning for innovation education. He leads educational design research in schools, hospitals, and corporations. For 5 years he was the UX Research Lead at ForgeWorks—an educational technology startup he co-founded.

Author Details

Pryce Davis

University of Nottingham
Assistant Professor in Learning Sciences, School of Education
Room C87 Dearing Building
Jubilee Campus
Wollaton Road
Nottingham
NG8 1BB
United Kingdom
pryce.davis@nottingham.ac.uk

Christina Krist

Stanford University
Associate Professor, Graduate School of Education
Raikes 217
507 Lasuen Mall
Stanford CA 94305
United States
stinakrist@stanford.edu

Daniel Rees Lewis

Northwestern University
Research Assistant Professor, Learning Sciences
2133 Sheridan Rd,
Evanston IL 60208
United States
daniel.rees.lewis@northwestern.edu

Editor Details**Prof. Dr. Tobias Jenert**

Chair of Higher education and Educational Development
University of Paderborn
Warburger Straße 100
Germany
+49 5251 60-2372
Tobias.Jenert@upb.de

Journal Details

EDeR – Educational Design Research
An International Journal for Design-Based Research in Education
ISSN: 2511-0667
uhh.de/EDeR
#EDeRJournal (our hashtag on social media services)

Published by

Hamburg Center for University Teaching and Learning (HUL)

University of Hamburg
Schlüterstraße 51
20146 Hamburg
Germany
+49 40 42838-9640
+49 40 42838-9650 (fax)
EDeR.HUL@uni-hamburg.de
hul.uni-hamburg.de

In collaboration with

Hamburg University Press

Verlag der Staats- und Universitätsbibliothek Hamburg –
Landesbetrieb
Von-Melle-Park 3
20146 Hamburg
Germany
+49 40 42838 7146
info.hup@sub.uni-hamburg.de
hup.sub.uni-hamburg.de