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Framing Educational Design Research: Abductive Reasoning and the Design of Theory.

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Abstract

In short, Educational Design Research (EDeR) can be defined as a rather pragmatist's approach with the intention to change an educational setting through an innovative intervention yet to be developed [1]. Researchers conducting this way of knowledge creation want to "change reality rather than just study it" [2]. They aim at contructing and refining specific "design principles and/or action heuristics for practical actions in a demarcated action field" [1]. EDeR researchers therefore pursue the goal to explore innovative solutions for problems in educational practice by an iterative design, while – at the same time – gaining new or at least refining scientific knowledge [1, 3–7].From an epistemological point of view, EDeR can be described as a scientific way of doing two things: (a) creating knowledge to solve specific problems of practical relevance in educational settings, and (b) drawing theoretical constructs (e.g.: generalized conclusions) from these particular design cases. It is not very clear, how to explain (b) methodologically – that is how to explain to build up new, innovative and practically useful theoretical constructs. In this paper, I would like to suggest that creation of theoretical constructs in EDeR could be methodologically considered as variations of abductive reasoning [8] – which might, compared to "conventional" approaches, even lead to more convincing ways of understanding EDeR.

1. Creating theory through design and evaluation of practical interventions: EDeR

Starting from specific problems in educational practice (e.g. in the field of classroom interactions), EDeR provides a very tight connection with empirical reality. Dealing with very specific practical issues by conducting iterative research cycles, EDeR permits the development of more general knowledge, leading to testable, relevant and viable theoretical frameworks in the field of (higher) education. What do researchers do when conducting this methodological approach? Although classifications still differ, and as there is not yet a broadly accepted methodology, most researchers agree on some basic principles. Following a systematisation developed by McKenney and Reeves [4], and complementing it with some theoretical specifications by Euler [1] and Sandoval [9], the following four steps can be defined to outline an EDeR research process:

1. Analysis/Exploration: **Finding and defining** a specific problem which is of practical relevance considering the educational goals of a specific setting by (a) analysing the actual situation and (b) anticipating potential developments. [2]
2. Design/Construction: **Contriving and developing** interventions, which are supposed to contribute to the solution of the defined problem in this educational setting.
3. Evaluation/Reflection: **Testing and differentiating** the designed solution, e.g. by means of formative tests or design experiments. [1]
4. Optimization: **Deriving adaptions** for the interventions considering the constraints identified during the evaluation process.

Following this outline, any EDeR study starts with a practical problem which has been identified in an educational setting and which needs to be solved in order to achieve the educational goals of this specific setting. By conducting EDeR, a possible solution is developed, and exploratively implemented into the setting. A detailed analysis of the whole educational situation then shows, which negative effects can be identified, obstructing the functionality of the intervention designed. Therefore, an enhanced version is designed to run through the whole process again. This scheme's sequences usually are described as an iterative process, that is, they are to be repeated multiple times.
So, step by step an elaborate version of an intervention at hand is developed, which is – after having run through several "cycles" – functional enough to provide a viable solution to the initial problem:

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> The research and development process is realized in iterate cycles of design, testing, analysis, and redesign. An incremental optimization of the design is effected within these cycles, and the development processes and principles are simultaneously documented [1].

The practical problem for which an intervention is constructed is mostly framed or reframed by *hypotheses* (conjectures, propositions) about the design [9]. These can be stated initially; they can be derived from empirical findings or they can result from the evaluation process. Taken this into account, it is obvious that EDeR cannot be defined by the methods applied in the process. Instead, it can only be defined by its purpose – that is, by the goals of an intervention which is to be developed [10]. Unfortunately, these courses often lack theoretical foundation, and they are mostly not linked to latest results and discourse of educational research in this field. This may be one of the reasons, why mostly undergraduates and students working on their Ph.D. thesis attend these courses. Senior lecturers or professors instead are very much under-represented.

2. Abductive reasoning as a way of gaining scientific knowledge

While there is an increasing amount of meta-research on how EDeR steps are to be processed to develop solutions for *practical* educational problems by iterative development, it is not very clear, how to explain methodologically, how *theoretical* constructs are influenced, or even rebuilt, in this process. As most researchers imply that new, innovative and practically useful theoretical constructs result from their EDeR research processes, there is very little reflection on how this development or further elaboration of new theoretical constructs is to be explained. Usually, the development of theoretical understanding in a design-based research process is described as act of *reasoning*: "Reasoning is a rational thought process by which existing ideas give rise to new ones. [...] [It] is central to the development of theoretical understanding" [4]. One kind of reasoning which, in my point of view, is of special significance to EDeR, is an inferential process that "generates hypotheses about relationships between observable phenomena" [4]. Following modern theory of argumentation, this kind of reasoning is commonly known as *hypothetical reasoning*, or *abductive reasoning*, or – in short – *abduction*: "Abduction is thinking from evidence to explanation, a type of reasoning characteristic of many different situations with incomplete information" [11]. By abductive reasoning, explanations are constructed hypothetically that give us a potential, *plausible* understanding of an observed (often puzzling) phenomenon – even if the explanations at the time being still lack empirical evidence and/or cannot be concluded necessarily (in a strictly logical sense) [8]. Thus, this kind of reasoning sometimes also is referred to as "presumptive reasoning" [13], or "plausibilistic" argumentation [14]. Although mostly not made explicit, this process of inferring is widely established in most research practices, as well as everyday problem solving. – It can even be described as a basic mechanism of human cognition [12]:

> Abduction is the process of *inferring* certain facts and/or laws and hypotheses that render some sentence plausible, that *explain* (and also sometimes *discover*) some (eventually new) phenomenon or observation; it is the process of reasoning in which explanatory hypotheses are formed and evaluated [12].

As far as knowledge, which results from EDeR processes is based on abductive inferences, EDeR from a philosophy of science perspective can be defined as a specific way of trying to scrutinise or to validate a potential (plausible) understanding of a phenomenon by experimental investigation:

> The experimental corroboration requirement […] gives an answer to the hypotheses selection problem of those that are explanatory. […] [T]he experimental corroboration of explanatory hypotheses goes beyond verification, as it requires of a calculation of its possible consequences or effects; those that produce new habits of conduct, being these epistemic or practical [11].

In contrast to classical philosophy of science (e.g. Popper), EDeR researchers may therefore claim that scientific knowledge and theoretical hypotheses cannot only be derived validly from strictly case-oriented analytical observation (inductive research) or from hypothesis-testing inquiry following a rationality of necessary or sufficient conditions (deductive research). Moreover, theoretical insights

may also result from a highly iterative process of abductive inquiry. Considering the "classical" approach of identifying research with the analysis, validation or evaluation of existing theories [15], this is a rather radical view. – Following EDeR's epistemological premises, the classic distinction between *descriptive* or *normative* research becomes obsolete. Design experiments are neither descriptive nor normative. They are *prospective* (as they lead to the construction of new theories) and *reflective* (as they analyse and interpret theories) at the same time. In order to scientifically substantiate both prospective and reflective aspects within this research methodology, multiple cycles of design, evaluation and optimization are to be run through [3]:

> On the prospective side, designs are implemented with a hypothesized learning process and the means of supporting it in mind in order to expose the details of that process to scrutiny. An equally important objective is to foster the emergence of other potential pathways for learning and development by capitalizing on contingencies that arise as the design unfolds. On the reflective side, design experiments are conjecture-driven tests, often at several levels of analysis. The initial design is a conjecture about the means of supporting a particular form of learning that is to be tested [3].

EDeR allows researchers to draw a generalized theoretical framework from single design cases by iteratively testing its decontextualized hypotheses. But in contrast with "classical" research forms, the process of knowledge creation is not preconfigured in advance (e.g. by stating an hypothesis at the beginning of a research process). Instead, the theoretical premises are derived "on the road" while conducting iterative EDeR cycles. This makes it possible to develop theory in a pragmatic way – through subsequent experimental adaption and reconfiguration.

3. Conclusion: Drawing theoretical constructs from design cases by means of abductive reasoning

As I have shown, one thing that makes EDeR special on an epistemological level is its interest in solving practical problems by the design and re-design of interventions [3]. Compared to 'classical' approaches, this way of doing research is based on abductive hypothesis-building, not solely empirical and/or logical evidence:

> Design research proceeds from the assumption that research cannot provide practical actions with certitude, but 'merely' a more or less empirically and/or theoretically well-founded orientation. [1]

This methodology is very similar to what is called the methodology of *qualitative experiments* or also *pilot project research* [3, 16–18].

In other words, EDeR aims at *applying* theories rather than analysing or revising them. Its key mechanism is to interpret data which cannot be explained adequately by the existing set of theoretical knowledge neither as a deficiency of the theoretical stock of knowledge at hand, nor discarding it as flawed data. Instead, one searches *creatively* for plausible arguments or rationale that help to explain the data observed, and that can be used as a working hypothesis to continue further exploration and evaluation. If a researcher manages to find some plausible hypothesis that helps to explain a surprising phenomenon he or she observed (which is a creative act that cannot be controlled completely), following Peirce, further iterative cycles are necessary to establish new scientific knowledge: Finding a plausible hypothesis is only the first step to establishing new theoretical understanding. The second step must be (in order to comply with a scientific methodology) to derive predictions from this hypothesis (deductive reasoning), to subsequently search for facts which verify the hypotheses made (inductive reasoning). If there are no facts to be found, more iterative cycles have to be completed [19, 20].

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