VIETNAM JOURNAL OF EDUCATION, 2025
Volume 9, Special Issue, 137-145
https://doi.org/10.52296/vje.2025.438

ORIGINAL ARTICLES

Design-Based Research - A Research Format for Educational Research

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Article history
Received: 03 September, 2024
Accepted: 22 January, 2025
Published: 20 April, 2025

Keywords
Design-Based Research, Africa, spatial perception, qualitative research, theory-practice connection

ABSTRACT
In educational research, the gap between university research and school practice is frequently pointed out. Particularly, the transfer of innovative scientific research findings into teaching practice occurs far too rarely or too late. Although theorists and teachers recognize and criticize the problem of theory-practice transfer, there are still few convincing concepts of how to sustainably address this challenge. The Design-Based Research approach offers a way to bridge the gap between theory and practice. Design-Based Research combines scientific theory, empirical research, and school practice. In this research format, scientists and teachers collaboratively develop theory-driven and practically tested teaching concepts or learning materials through iterative research cycles. Design-Based Research projects aim to find practical solutions to the challenges that have been identified in teaching. Design-Based Research not only facilitates the development of solutions for teaching practice, but it also generates contributions to subject-specific didactic theory through the research process. A significant advantage of Design-Based Research is that the results of a Design-Based Research project can be implemented in the classroom more quickly, due to the close cooperation between theorists and practitioners. The paper demonstrates the implementation of Design-Based Research in Geography Education through a case study on Africa.

1. INTRODUCTION

The relationship between theory and practice has long been the subject of controversial debate in teacher education (Bommes et al., 1995, p. 28). In this article, however, the focus is not on an "optimal relationship between theory and practice" (Bresges et al., 2019) in teacher education, but rather on the inadequate theory-practice transfer of scientific research results into teaching practice. This problem is identified by representatives of both practice and theory. From the point of view of teachers, too few new scientific findings find their way into school practice, and often only after a very long delay. They also complain that although the outcome of university research results serves currently relevant fields of research in education, they are often not suitable for solving challenges that are relevant to teaching practice (Esteves, 2012). At the individual level of teachers, it is also evident that the steadily increasing own teaching experience, which is reflected and consolidated in teachers' experience-based subjective theories about good teaching in the course of their professionalization process, can hinder the implementation of new, current research findings in their own teaching. As a result, open-mindedness towards educational innovations, such as those that can be created through Design-Based Research (DBR) decreases. Over 40 years ago, the Model of Skill Acquisition (Dreyfuß & Dreyfuß, 1980) showed that so-called "situational knowledge" is particularly important for lesson design in the "proficient" and "expert" levels of the model. This means that although teachers still draw on

theory here, it is always adapted to their own experiences and the specific school and classroom situation. Theory only serves as background knowledge that is used flexibly and contextually while practice and personal reflection play an increasingly important role.

Representatives of theory, on the other hand, point out that practice-based empirical teaching research is often made more difficult by the organizational and legal framework conditions of the school as an institution. The idea of integrating practice into "subject-didactic theory development" (Feulner et al., 2015, p. 266), from which student teachers and teaching staff could benefit, has thus far hardly been perceived by theorists as an opportunity to initiate research relevant to teaching (Schmiedebach & Wegner, 2021, p. 8). The different perspectives on the transfer problem also seem to be supported by the fact that theory is "integrated into the academic system,... and takes place in the university organization while practice is linked to the educational system and the school organization. Both systems and organizations follow their own logics and rules and have a high degree of autonomy" (Hedtke, 2000, p. 2). As a result, they can be regarded as operationally impenetrable and are difficult to disrupt by the other system (Bommes et al. 1995, pp. 35-36).

DBR as a research framework is suitable for building a bridge between theory and practice (Fischer et al., 2003) in the school context. Its use can counteract the decoupling of research/theory from practice (Tulodziecki et al., 2013, p. 210). Reinmann (2005, pp. 66-67) even says that the DBR approach has the potential to "become the nucleus for theory development and scientific progress in the field of learning and teaching,..." because "theory and practice are not regarded as separate entities to be worked on sequentially, which have no contact without 'bridge-building'. DBR can therefore contribute to a better interweaving of theory and practice, since "the goals pursued are always twofold: on the one hand, relevant problems from educational practice are to be solved, and on the other hand, theory-generating or theory-developing results are to be obtained" (Schmiedebach & Wegner, 2021, p. 3).

DBR therefore refers to the iterative process of developing, implementing and evaluating interventions in order to solve practical problems and generate theoretical knowledge at the same time. Both qualitative and quantitative methods can be used flexibly in DBR. However, only with qualitative research is it possible to capture and reveal the necessary in-depth understanding of the complexity of learning environments and processes as well as the associated opportunities and challenges. Empirically collected qualitative data also helps to gain a deeper understanding of the subjective theories and interests of all stakeholders involved in the DBR in order to take their perspectives into account in the research process. By analyzing all qualitatively collected data, theories and models can be generated, which can then be tested and evaluated in the respective practical teaching context. Suitable methods includes interviews, observations, case studies and document analyses. In the DBR, quantitative methods are used to measure the effects of the interventions developed and to make statistically verified statements about their effectiveness.

In the following section, the DBR approach will be presented both theoretically and by using a case study on Africa in Geography Education in the context described.

2. THEORETICAL FRAMEWORK

Design-Based Research as an approach in qualitative research

The DBR approach is a methodological framework (Bakker, 2018) that has its starting point in the theory-practice problem described above, but is not characterized by an exclusively qualitative methodology. Decisive for the development of sustainable educational innovations through DBR is the selection of suitable qualitative methods, which must be tailored to the design development and optimization of interventions. This central objective allows DBR to be classified as qualitative research in its essence. However, scientific research also means measuring the effects and effectiveness of interventions in order to be able to evaluate and optimize them. The quality criterion of the generalizability of research findings also plays a role and legitimizes the use of quantitative methods. Method triangulation (Flick, 2005, p. 9) makes it possible to take a multi-perspective view of the DBR research process and its results. By using mainly qualitative but also quantitative methods in the DBR, the relevance of the DBR approach for school practice is taken into account and the criterion of the scientific nature of the approach is fulfilled. This also corresponds to the intention of DBR to link empirical educational research with the systematic, theory-based development of teaching-learning environments and teaching materials (DBR Collective, 2003, p. 5). According to Beireiter (2002, p. 326), DBR can be both basic research, applied research and evaluation research and initially emerged in the 1990s as a reaction to criticism of traditional experimental research approaches, which were often

seen as too artificial and remote from practice (Brown, 1992; Collins, 1992). Since the 2010s, the approach has also become increasingly established in the educational sciences (Malmberg, 2020, p. 81).

In the context of DBR, 'design' means the process of systematically designing, developing and implementing interventions that serve to address specific problems or challenges in real educational and learning contexts. Teaching-learning environments or teaching materials as products of DBR are developed and evaluated in close cooperation between education scientists (theory) and school practitioners (practice) during the entire research process and in a theory-based and empirically sound manner. The concrete procedure of DBR is presented in Part 3.

DBR fulfils the criteria of qualitative research through the following scientifically sound characteristics:

- *Contextuality*: DBR enables phenomena or problems to be investigated in their natural, complex context, i.e. in the school environment, in a holistic way, which is typical of qualitative research. Findings are gained in the direct context of the specific educational environment rather than under controlled laboratory conditions.

- *Iterative development*: DBR utilizes an iterative research process in which interventions are developed, tested and continuously refined. This iterative approach enables flexible adaptation to emergent findings.

- *Reflective practice*: Reflection on the design, implementation and results of research is crucial in DBR in order to develop a deeper understanding of a previously unknown phenomenon or problem.

- *Importance of the subjective*: DBR recognizes the importance of subjective experiences and perspectives of those involved in the research process, which is in line with the qualitative paradigm that emphasizes subjective perceptions and constructions of meaning.

Compared to other qualitative research methods, the DBR approach is therefore characterized by its strongly interventionist nature. It differs significantly from other qualitative research formats because all intervention steps are neither upstream nor downstream of the actual research process, but, instead, their development and evaluation are an essential part of it. While other methods of qualitative research have so far tended to be primarily descriptive and exploratory, DBR pursues a dual objective: to achieve practical educational benefits while at the same time generate theoretical knowledge (cf. Reinmann, 2005).

At first glance, DBR may appear similar to action research. Action research, which is becoming increasingly important in Vietnam, also aims to improve teaching practices and shares many similarities with DBR. However, the two approaches differ primarily in their focus: DBR emphasizes the development of theories that are applicable beyond a specific context, whereas action research concentrates on the immediate improvement of practices within a local context (Wang & Hannafin, 2005; Reeves et al., 2005). Additionally, in action research, the educator typically assumes the dual role of researcher and practitioner. In contrast, DBR involves a collaborative partnership between researchers and practitioners, as it is often assumed that teachers are too busy and may lack the necessary qualifications to conduct scientific research independently (Anderson & Shattuck, 2012, p. 17).

Potential of Design-Based Research in education research

A concrete opportunity for linking research and practice in DBR is that practical teaching challenges are not only described, analyzed and explained theoretically by academics, but they are also accompanied by concrete, tried-and-tested implementation options for the design of lessons and teaching materials. Equal cooperation and communication between researchers and teachers in DBR is essential for this, as DBR's iterative research process makes it possible to incorporate ideas, findings and experiences from both sides into the development of a practicable and theory-based action product from the outset. This makes teaching-learning processes understandable on the one hand and more controllable on the other. This can help teachers to reflect on and reorganize their teaching on the basis of theory. For their part, education scientists can fulfil the requirement to link their research projects even more self-reflectively and thus more precisely to practice (Reinmann, 2005, p. 6).

A further potential of the research approach in the area of lesson development and evaluation is that all implementation processes of the results of a DBR project in school practice are scientifically monitored in order to be able to "successfully shape the conditions for success" (Kultusministerkonferenz, 2016, p. 6, own translation). This can be one way of counteracting the lack of support from the theoretical side, which was criticized by teachers in the Esteves (2012) study, for example. It also paves the way for the rapid transfer of research-based innovations into teaching practice. Both science and practice benefit from DBR because practical theories are generated, which are not only powerful in terms of explanation, but they also have a great potential for application. Teachers can see

their involvement in a DBR process as part of their personal professionalization process. This gives them the opportunity to question the impact of their experience-based teaching while incorporating theoretical findings (Malmberg, 2020, p. 89), ideally with the aim of optimizing it.

Research results from DBR can thus contribute to the quality of teaching as well as provide an impetus in the design of curricula. Ideally, a positive experience of the dovetailing of theory and practice within the framework of DBR leads to a reduction in 'fear of contact' between academics and teachers, thereby leading to further cooperation. The DBR approach could also be suitable as a research format in connection with the implementation of education for sustainable development in schools. Feulner et al. (2015, p. 266) point out that teachers find it very difficult to deal with the enormous factual and ethical complexity of global challenges (Ohl, 2013) and thus be able to master them in the classroom. They note that, while teachers already have access to a wealth of materials and teaching-learning arrangements for education for sustainable development, "research into their effects in practical use and further development based on this" is still lacking. "Especially in ESD (education for sustainable development), the gap between the demands of science and society and the actual handling of the corresponding issues in the classroom sometimes seems particularly vast. The DBR approach is particularly suitable here, as it is designed from the outset for close cooperation between researchers and practitioners" (Feulner et al., 2015, p. 266).

3. METHODOLOGICAL FOUNDATIONS USING THE EXAMPLE OF IMAGES ABOUT AFRICA

DBR proceeds in cycles of design, implementation, evaluation, reflection and revision. The phases are presented in more detail below and linked to a specific application example for a better understanding. The example shows a case study on deconstructing perceptions and stereotypes on Africa. Two of the authors worked closely together throughout the DBR cycle, one as a theorist, the other as a teacher who was still working in practice at the time. The collaboration took place both at the university (theoretical development) and at the school (testing in practice). The fact that both institutions were located in the same city was conducive to this location.

Design phase

Identification of research questions and problems

The design phase begins with identifying and defining the research questions and problems at hand. These questions should have both practical relevance and theoretical interest. They are often developed in collaboration with practice partners such as teachers, school leaders or other stakeholders. A sound understanding of the context and the existing challenges is crucial for the formulation of relevant and realizable research questions. In the example presented, the question centers on images of Africa among pupils. Not only in literature but also in the classroom and in empirical research, it has been established that images of Africa in Europe, especially among schoolchildren, are characterized by associations with wars, crises, disasters, diseases, hunger and poverty. At the same time, there are sometimes romanticized images that originate primarily from novels, cinema and television films (Arndt, 2006; Awet, 2018; Knauer, 2009; Reichart-Burikukiye, 2001; Schmidt-Wulffen, 1997; Tröger, 1993). These one-dimensional representations and perceptions, and thus the consolidation of predominantly negative stereotypes, not only obscure the complexity and diversity of the continent but, above all, also contribute to polarization and oftentimes to an exaggeration of own values, norms and behavior. This in turn reinforces postcolonial and racist structures that undermine fair, respectful and productive global interaction. Therefore, the aim of this study was to examine whether and how geography lessons can contribute to breaking down these deeply rooted images of Africa.

Literature review and theoretical foundation

After formulating the research questions, a comprehensive review of literature was conducted to understand the current state of research and to identify theoretical models that can serve as a basis for the design. This theoretical grounding is crucial to ensure that the interventions developed are both innovative and empirically based. For some time now, geography didactics has been concerned with influencing images of Africa in the minds of pupils. This influence has been primarily understood in the sense of instructive approach instructional theory, by attempting to present a less racist and more diverse image, for example. In doing so, particular attention was paid to the choice of language and words and the selection of images, especially in textbooks. Pictures were no longer being shown only from rural areas but also from urban settlements. In order to create a more positive approach, topics such as wars and crises were avoided and, instead, the lives of young people of the same age were depicted in order to find similarities. However, the Eurocentric views of the African continent could not be sustainably influenced or changed by this

rather instructional approach. In terms of a constructivist approach, it could be concluded that pupils should be able to reflect on and critically scrutinize their own images in their heads as well as images in textbooks, magazines or internet media. Perceptions of spaces and cultures of Africa must be analyzed in terms of their multi-perspectivity and construction processes, and the pupils must be made aware of their intentions. Pupils must come to terms with their own evaluation systems - become aware of their 'cultural glasses', so to speak, through which they have learnt to evaluate their values and norms. A further step, then, is to compare these values and norms to other perspectives and to evaluate them on the basis of other possible values and norms. The ways in which the respective space "... is perceived by different people..." are examined (Coen & Hoffmann, 2008, p. 153, own translation). Recognizing and questioning different perceptions of spaces requires enduring uncertainties, recognizing different views on an equal footing and critically reflecting on one's own views that are assumed to be immovable (Schneider et al., 2008; Kersting, 2011). The focus here is on the ability to understand one's own perception as a result of socialization.

Development of prototypes and interventions

Based on the research questions identified and the theoretical foundation, initial prototypes or interventions are developed. These designs should be flexible enough to be adapted and refined during the implementation phase. The development process can be collaborative and should include the involvement of practice partners to ensure practicability. The planned lessons should be based primarily on images, so as to challenge perceptions. Images are an essential part of geography teaching. However, one and the same image can be perceived differently by different people (Höpel, 2008, p. 62; Nöthen & Schlottmann, 2015). These differences in perception and evaluation vary greatly, particularly in the case of images from Africa. For this reason, assorted images showing everyday situations in Tanzania were initially selected, together with colleagues from Tanzania. The selection of images was then narrowed down to 19. This step was intended to ensure that the images depicted common situations. In guided interviews, 25 adults in Tanzania were asked about their description and assessment of the respective situation in the pictures. Adults were deliberately chosen as interview partners, as a certain degree of experience and meta-reflection must be assumed, in order to justify the judgement and evaluation of the photos, as this is normally more likely to be the case with adults. In Germany, the pictures were presented to 12 pupils from different age groups. They were also asked to describe and evaluate the pictures. All interview transcripts were analyzed using summarized content analysis. In this way, the central statements from both perspectives could be extracted for each picture. The results were initially used to select those images where the perceptions of the interviewees in Tanzania and the pupils in Germany differed the most. The selected images included the following picture, for example:

Figure 1. (Photo: G. Schrüfer)

The key messages from Tanzanians of this image could be as follows: - *You can recognize an unfinished building that could be a shop in terms of its structure and location; - Building a house takes a long time, often many years, because it is built in stages, whenever money is available. This is why it can happen that plants settle in the shell of the building; - If you want to build a house, you put all your money into it straight away, as prices rise almost daily due to inflation; - Saved money usually has to be shared with family members in need, which is why no large sums can be saved; - Building societies are not available. The entire sum cannot be borrowed from the bank due to a lack of creditworthiness.*

The main statements made by students from Germany were as follows: - *This is a house that has been started in poor economic or poor conditions, which is not beautiful and will not be finished and is therefore more of a waste of space. In Germany, on the other hand, there is more luxury; - This is an old, dilapidated stone building with vegetation; - The condition and decay of the building bear witness to the poverty of the people; - This used to be a house that was damaged by bombs and is now broken; - You feel sorry for the people who used to live in it; - The garbage should also be removed so that the environment is not polluted.* It becomes clear that the perception of the pupils in Germany is primarily characterized by their stereotypes.

In collaboration with teachers, a teaching unit was developed whereby students were first assigned a picture and then asked to describe it. They were given the central statements from the Tanzanians regarding the respective picture, thereby being exposed to different spatial perceptions. In a classroom discussion, the possible causes of differing perceptions were analyzed and particularly reflected upon. The main goal was to sensitize the learners to critically question their own spatial perceptions, especially concerning their own images of Africa.

Implementation Phase

During the implementation phase, the developed teaching unit, including the respective images, tasks, and central statements from different perspectives, was tested. The lessons were conducted by the respective teachers in various grade levels. The researchers observed and recorded the lessons and, following the double period, conducted group discussions with both the teachers and the students. These discussions were recorded, transcribed, and analyzed. The focus was on questions to increase one's knowledge as well as the feasibility, motivation, and comprehensibility of the unit.

Evaluation Phase

In this phase, the data collected up to this point was analyzed. The data from various classes and with different images were compared. A key focus of the analysis was on the group discussions among students, particularly on the extent to which and through which prompts students were sensitized to recognize other perceptions as possible constructs and to see their own perception as just one construct among many. The data analysis was iterative, meaning that changes were made after each lesson. In this phase, for example, two images were removed from the sample as they did not provide the desired depth of reflection for the students. In addition, the work in the small group was preceded by individual work. This process helped to identify strengths and weaknesses, which were crucial for necessary adjustments and modifications. The data from the various cycles were compared and interpreted to identify patterns and correlations.

Reflection and Revision Phase

The reflection and revision phase was a crucial stage although it could not always be distinctly separated from the previous phase. During this phase, teachers and researchers jointly discussed and reflected on the analysis results. A particular focus was placed on comparing the expectations of the teachers and researchers with the actual outcomes. Even during this phase, minor changes were made or selected, based on their effectiveness in previous phases. In the example, the focus was primarly on discussion and meta-reflection. Various questions were posed to the pupils and finally those that led to in-depth reflection were selected. It became clear again and again that the initial surprise that other people see a picture that they thought was objective differently was the initial spark for reflection. This ongoing development also led to theoretical conclusions. The hypothesis was formed that the confrontation with significantly different perceptions of unfamiliar spaces (like Africa) provides valuable prompts for reflecting on one's own perceptions. However, these reflections should be expounded upon in a subsequent discussion. The materials were further tested in three additional classes until teachers and researchers were satisfied with the results, and the hypothesis could be confirmed.

4. CHALLENGES AND CONCLUSION

The inherent development of interventions is the outstanding feature of DBR. However, DBR projects are often very complex and time-consuming because they require multiple iterative cycles and ongoing close collaboration between researchers and teachers. This can demand resources and time that may not always be available to both parties. Close collaboration with school-based practice partners also requires special considerations and planning activities, particularly regarding informed consent and data confidentiality. Ensuring transparent and respectful interaction among all participants is essential in this process. This also includes the recurring discussion about equal cooperation between academics and practitioners, which often goes hand in hand with the question of the balance of power between the two actors in DBR. One characteristic of equality in DBR is, for example, the co-creation of knowledge, as DBR is based on the joint development and testing of interventions in real contexts.

In this example, the scientists contributed theoretical knowledge about dealing with stereotypes of images of Africa and corresponding research skills while teachers provided rich, experience-based teaching expertise and enabled access to the school and classroom context (see Chapter 1), without which the project would not have been feasible. Another feature of the cooperation throughout the DBR cycle was the permanent mutual validation. Scientific findings were applied in the lessons and checked for their practicability.

Teachers benefited from scientifically supported findings from the research project, e.g. regarding how students deal with stereotypes about Africa. Scientists generated theoretical insights that they derived from their observations of the classroom implementation of the interventions and from interviews with students. Ultimately, both sides were responsible for implementing the results. As a result, the teachers benefited from the collaboration by taking the opportunity to reflect on their lessons in terms of dealing with stereotypes in order to optimize them, now based on theory. The scientists took the opportunity to further develop theories on how to deal with stereotypes using a curriculum-relevant example - the perception of images in the context of Africa.

However, whether theorists and practitioners are seen as equal partners is always a question of the attitude or mindset of those involved or of other people. If the attitude prevails that the scientific knowledge of theorists is more valuable and thus superior to the experiential knowledge of teachers, or vice versa, then the aspect of equality can always be critically questioned. This successful research project can serve as an example of how equal cooperation based on mutual appreciation can work.

The limited generalizability of the results due to the context-bound nature of individual cases as a fundamental criticism of qualitative research can be counteracted with the help of method triangulation (see Chapter 2).

Although DBR is not yet one of the established formats in educational research, and although Reinmann (2005, p. 6, own translation) mentions further challenges such as the "methodological standardization of DBR, its presentation and publication, and research funding," the DBR approach nonetheless has future potential in educational research. It addresses complex and multifaceted content and methodological challenges that are important for teachers in their daily teaching activities and for which there are practically no theory-based and implementable solutions yet. The collaboration between researchers and practitioners in DBR projects enables the development of practical solutions while simultaneously generating theoretical insights. Therefore, it is suitable for counteracting the described theory-practice transfer dilemma.

Conflict of Interest: No potential conflict of interest relevant to this article was reported.

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