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# DESIGN RESEARCH AND THE SOLO HIGHER DEGREE RESEARCH STUDENT: STRATEGIES TO EMBED TRUSTWORTHINESS AND VALIDITY INTO THE RESEARCH DESIGN

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Abstract

This paper puts forward a set of criteria for ensuring trustworthiness in design research studies undertaken by Higher Degree Research (HDR) students. Design research is aimed at exploring educational problems and refining theory and practice by defining a pedagogical outcome and is a methodological approach often associated with the Learning Sciences. In this paper, how a solo HDR researcher can use a design research approach to maximise the benefits of the methodology without compromising the validity of the research design will be discussed. The criteria put forward to ensure reliability fall into two categories; trustworthiness and the research design. Overall, there is a perceived need and value for HDR students to contribute to the understandings of design studies which are guided by a trustworthy research design.

Key Words**:** Design research, Higher Degree Research, technology and learning, research into doctoral education

## Introduction

This paper offers perspectives on design research and the Higher Degree Research (HDR) experience. In research in the field of computer-supported learning the use of design research has gained a reputation as being the methodology of choice for the Learning Sciences and educational technology research (see, for example, (Barab, 2006; Barab & Squire, 2004; Edelson, 2002; Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004; The Design-Based Research Collective, 2003). Design research lends itself to this field educational technology research as its underlying premise is to develop the design of artefacts, technological tools, and curriculum and to further an existing theory or develop new theories in naturalistic settings that can support and lead to an enhanced understanding of learning (Barab, Dodge, Thomas, Jackson, & Tuzun, 2007; Barab & Squire, 2004; Fishman, et al., 2004). There has been a call for research that is focused on the design process itself at local level, as Schoenfeld (2009) explains that 'the products of well conducted design experiments are improved interventions *and* improved understandings of the processes that result in their productiveness', which are productive contributions to the research community.

One characteristic of design research is the use of cross-disciplinary or multidisciplinary teams. The multidisciplinary teams are showcased in ongoing design studies, such as *Quest Atlantis* or *River City*, wherein the research often draws on the experience of several fields, such as the research staff, teachers, technological support staff, statisticians, the students and external stakeholders, such as government funding bodies (Ketelehut, et al., 2010; Barab, et al. 2007). This use of multidisciplinary research teams is seen as a strength of design research as a greater breadth of understanding can be brought into the research environment (Reeves, et al., 2005; Wang & Hannafin, 2005). Cobb et al. (2003) clarify that the size and type of research team depends on the purpose of the research and they explain that a one-to-one research design may be appropriate in a study wherein the researcher is conducting the teaching sessions. It is this, one-to-one research design that underpins the remainder of the paper.

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In the HDR context, research students are often seen as working 'solo' on projects. That is to say, HDR candidates while not working in isolation may not be working collaboratively or are not part of a formalised research project, such as a grant funded project. While they are working 'solo' on their own research, it can also be argued that HDR students, and all researchers, are part of a faculty or department and are thus able to draw from multi-disciplinary perspectives. It should be clarified here, that we are not stipulating that a HDR student that is conducting an investigation in the field must use this methodology. Rather, we argue that if a design research approach is the most appropriate methodology to investigate a research question then there are strategies that a solo researcher can use to ensure the integrity of the research design. In this paper, several measures are presented that a solo researcher can include in their design to fortify the validity and trustworthiness of their research design.

## Background

### Design Research

'Design research' was put forward as a research approach that extends existing methods as a means to address the issue of linking theory and practice in educational research. The coining of the term 'design research' is credited to Ann Brown in 1992 (Collins, Joseph, & Bielaczyc, 2004). Brown's (1992) 'design research' converged qualitative and quantitative operations, collected multifaceted data and focused on in-depth proving of theory. Wang and Hannafin (2005) note that similar and sometimes interchanged terms, such as 'design experiments', 'design-based research', 'development research', and 'developmental research and formative research', are often grouped with design research. While there are differences between the approaches many of the characteristics are shared. In this paper the term design research will be used.

Design research is aimed at exploring educational problems and refining theory and practice by defining a pedagogical outcome and then focusing on how to create a learning environment that supports the outcome (Reeves, Herrington, & Oliver, 2005; Wang & Hannafin, 2005). According to Plomp (2007), design research is:

> Like all systematic educational and instructional design processes – therefore cyclical in character: analysis, design, evaluation and revision activities are iterated until a satisfying balance between ideas ('the intended') and realisation has been achieved' (p.13).

While design research has since been used across a range of educational settings, the basic concept of the research design is still very much apparent. Confrey (2006) explains that a design research study:

> Seeks to document what resources and prior knowledge the student brings to the task, how students and teachers interact, how records and inscriptions are created, how conceptions emerge and change, what resources are used, and how teaching is accomplished over the course of instruction, by studying student work, video records, and classroom assessments (p.135).

Three fundamental principles of design research are outlined by Reeves (2006):

> addressing complex problems in real contexts in collaboration with practitioners; integrating known and hypothetical design principles with technological advances to render plausible solutions to these complex problems; and conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles (p.58).

The ultimate goal of design research is to 'build a stronger connection between educational research and real world problems' (Amiel & Reeves, 2008, p. 34). The focus on iteration is not just to evaluate an innovation, for example a hardware or software, but rather to produce and refine design principles that can provide guidance for similar research studies or development endeavours (Amiel & Reeves, 2008). In Figure 1, a model of design research illustrates the iterative cycles which are characteristic of design research are part of the process of refining the solutions. It can be seen that that a design research approach supports development of design principles through a cycle of reflection, evaluation and refinement.

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Ongoing cycles of reflection, iteration and re-design are allied with design research. The process of data collection is sustained over a period of several years. In studies into *River City*, a multi-user virtual environment used for scientific inquiry learning in high school, the evolution of the city and the design of the inquiry materials resulted from ongoing cycles of design and reflection (Ketelhut, Clarke, & Nelson, 2010; Ketelhut, Dede, Clarke, & Nelson, 2006). The reflection on the data gathered and subsequent re-design or addressing of issues is aimed at addressing the learning issue and achieving the research goals. As Wang and Hannafin (2005) suggest, in a design research study, data are analysed immediately, continuously and retrospectively and that part of this cycle of data collection involves stages such as a comprehensive literature review coupled with the systematic and purposeful implementation of research methods. This iterative process leads to the development of design principles, which are then reflected upon and evaluated through the refinement of the problem, solutions and methods. According to Amiel and Reeves (2008):

> The development of design principles will undergo a series of testing and refinement cycles. Data is collected systematically in order to re-define the problems, possible solutions, and the principles that might best address them. As data is re-examined and reflected upon, new designs are created and implemented, producing a continuous cycle of design-reflection-design (p.35).

What this means is that a research or research team systematically uses iterative cycles of design that inform subsequent design in a process of refining and redefinition of the design and the achievement of goals and the development or building on of valid theory (Edelson, 2002; Reeves, et al., 2005; Wang & Hannafin, 2005). Hence, through the cycles of analysis, development, testing and refinement and reflection and evaluation, the principles and the solution implementation are revised and refined.

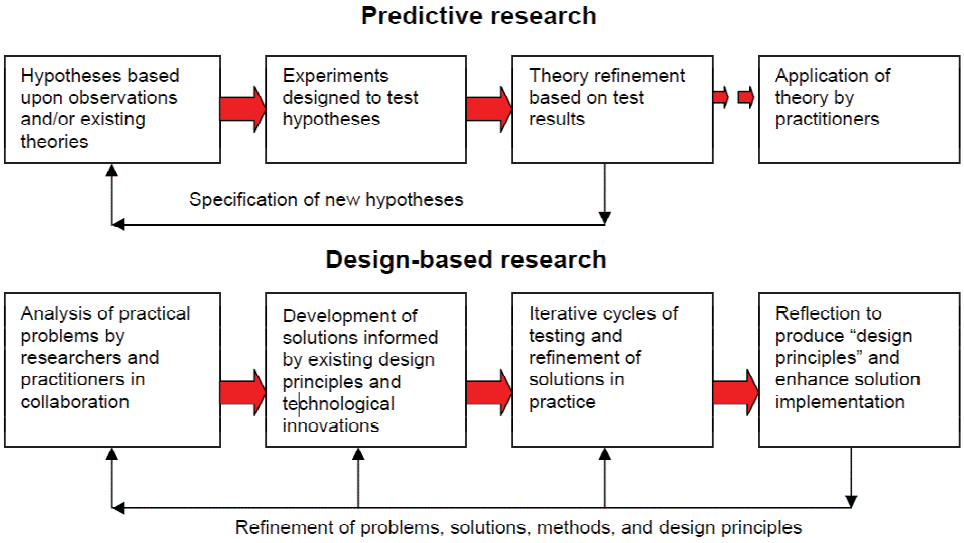


*Figure 1. Model of Design-Based Research (Amiel & Reeves, 2008)*

In this respect, design research is often seen as a series of approaches, rather than a single approach that is aimed at the development of new theories and practices in naturalistic settings (Barab & Squire, 2004; The Design-Based Research Collective, 2003). The emphasis on naturalistic settings is emphasised in discourse on design research as the focus is on developing contextualised, but sharable, theories and cumulative design knowledge in classroom or learning environments. This is articulated by Schoenfeld (2009) who states that 'properly constructed, a design experiment consists of the creation of an instructional intervention on the basis of a local theory regarding the development of particular understandings'. Design research combines qualitative and quantitative data collection approaches, this combination of data collection strategies allows for a more robust

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understanding of the learning environment (Bannan-Ritland, 2003; Brown, 1992; Fishman, et al., 2004; The Design-Based Research Collective, 2003; Wang & Hannafin, 2005).

Design research has been used across a range of educational settings this is due to in part to the adaptability of the design to classrooms, as Reimann (2010) explains 'one of the main motivations behind design research is to make learning research more relevant for classroom practices' (p.37). As such, design research tends to be adopted by researchers who are conducting studies in authentic classroom situations in order to generate theory and design relevant to a particular context. Design research is often at the convergence of design and theory and the design research framework supports traditional outcome-based evaluation and the importance of design (Edelson, 2002). The emphasis is not on refining education practice, but on addressing and dealing with theoretical issues and questions that arise (Collins, et al., 2004). Systematic evaluation of the consecutive research phases or iterations contributes to theory building (Plomp, 2007).

While design research is often associated with the Learning Sciences, a field that is known for its utilisation of technology in education, the focus of a design research approach is on pedagogy and learning theories rather than on the development of technological tools and artefacts (Barab & Squire, 2004; Wang & Hannafin, 2005). While technology is often an important feature of research that adopts a design research approach, the learner and the teachers are still the focus. The use of authentic settings contribute to the research process and the legitimacy of the research is reflected in the acknowledgement of both the success and the failures, and if the authenticity of the environment is compromised as a result of the research, then this must too be documented and reflected upon in the data analysis (Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004).

Plomp (2007) outlines several dilemmas of design research. These are that the researcher is the designer and often the evaluator and implementer. Real world settings, such as the classroom, result in real world complications. There is also an issue of the adaptability. Each cycle of design research considers the findings of the preceding cycle; hence, the research design needs to be flexibly adaptive. One issue that is raised in critiques and literature on design research is how research undertaken at a local level can contribute to broader theories of learning and design (see, for example, Dede (2004)). As Barab and Squire (2004) note, it is easy to show learning gains at a local level, such as a classroom or school, but it is difficult to show the usefulness and consequentiality of this work at a larger level. This adaptability is also question by Dede (2004), who finds that often the results of a design research activity are common sense, the large data set results in very general and under conceptualised findings. Dede (2004) also notes that the cycles of iteration may incorporate numerous conditions for success that may affect the adoption of the design or theory at a large level. Scale and sustainability of the findings on broader levels are questioned by Fishman et al. (2004) and Barab et al. (2006) who point out that variables such as ease of adoption, sustainability of the design or theory and spread are dependent variables that needs to be considered in the research. This final issue is perhaps the most crucial factor that impacts upon a higher research student's ability to undertake design research. Given that access to schools and recruiting participants is difficult. It is unlikely that a solo student research will be able to show the usefulness of their design at a larger level.

Schoenfeld (2009) outlines several areas where HDR students can contribute both to areas of research and in clarifying the design research process. He suggests that HDR students can (a) chronicle the design process and the piloting process, this could give rise to a range of design heuristics and descriptors of design principles that proved to be productive, (b) document professional pathways and essential skills for educational designers , (c) explore and identify the ways in the phases or aspects of the design process contributed to the final study or product, this may include top-down and checklists of 'fail-safes' for the design process, and (d) focus on a specific area of knowledge in the design process, such as design principles, design techniques or professional practice, and investigating the impact of these areas and how they work. As such, there is a perceived need and value for HDR students to contribute to the understandings of design studies which are guided by a trustworthy research design.

## Ensuring Trustworthiness in the Research Design

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In order to ensure trustworthiness in a solo researcher design research study the inclusion of several criteria are proposed. These are based, in part, on Guba's (1981) criteria that should be considered by qualitative researchers in pursuit of a trustworthy study: dependability, credibility, transferability, confirmability. The criteria engaged in HDR, such as Mafumiko's (2006) thesis on curriculum redesign and Squire's (2004) thesis on game-based learning, to ensure reliability and trustworthiness are also drawn upon for research design. The criteria are outlined in Table 1.

*Table 1.* Strategies to Support Reliability in Solo Research

| **Trustworthiness** | | |
|---|---|---|
| | Description | Clarification |
| Dependability | Work repeated in same context with similar methods and participants the results would be similar | Replication of phases with similar student cohorts |
| Credibility | To seek to ensure that a study measures or tests what is actually intended | A study that supports prolonged exposure and persistent observation of the student group. Ongoing peer debriefing |
| Transferability | The extent to which the findings from one study can be applied to another | Provide information on the duration of the study, the number of organisations and their locations, number of participants, data collection methods, number and length of data collection sessions |
| Confirmability | To seek to ensure that the findings of the research are the result of the ideas and experiences of the participants rather than the characteristics and preferences of the researcher | Acknowledge the shortcomings in study's methods and their potential effects on the research. The inclusion of an in-depth methodological description |
| **Design** | | |
| | Description | Clarification |
| Micro-phases | Series of iterative data collection phases that test and evaluate design. Each cycle in the study is a piece of research in itself | Several tests of materials prior to main field test that examine a different aspect of the design or theory |
| Expert groups | The inclusion of several expert groups throughout the study to evaluate the materials and data collection instruments | Engage with a mentor external to research of visiting scholars to review design. Submit research stages for peer review in conferences |
| Different participant groups | Test materials with a range of participants groups | Engage groups, such as teachers, pre-service teachers, designers, in study prior to testing with students |

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| | | |
|---|---|---|
| Flexibly adaptive | Ability to take on several roles without losing sight of the role of researcher | Use of evolutionary planning framework which is responsive to field data and experiences as acceptable moments during the course of a study |

## Trustworthiness

The criteria to ensure trustworthiness presented in Table 1 are expanded on below.

### Dependability

Dependability is linked to both credibility and confirmability (Lincoln & Guba, 1985). According to Shenton (2004), a researcher can establish dependability 'if the work were repeated, in the same context, with the same methods and with the same participants, similar results would be obtained' (p.71). Hence each stage of the study should be informed by research on similar studies. In addition develop the consistency of the approach, the repetition of the phases is encouraged in investigation of 'all reasonable areas' to ensure that early closure does not occur, thus reducing the impact of researcher bias (Lincoln & Guba, 1985).

As reliability of the instruments is of great importance too, repeating the use of the survey instruments should ensure that the methods are reliable (Leedy & Ellis Ormrod, 2005; Punch, 1998). This testing of replication should be feasible and may allow for the reliability of the methods.

### Credibility

The trustworthiness of design research study is intrinsically linked to credibility. Shenton (2004) explains that to establish credibility is to 'seek to ensure that their study measures or tests what is actually intended' (p.64). The term 'credibility' has been used in place of 'internal validity' and Lincoln and Guba (1985) propose five ways of ensuring credibility: prolonged engagement, persistent observation, triangulation, peer debriefing and negative case analysis.

### Prolonged engagement

According to Lincoln and Guba (1985), prolonged engagement is crucial in helping to support the concept of credibility in qualitative research because it assists the researcher in testing for misinformation and building trust. Given the iterative nature of design research it is possible for a researcher to have prolonged engagement with a design. However, having prolonged engagement with a cohort of participants in a school or university context can be challenging.

### Persistent observation

Persistent observation is the ongoing observation of participants in a study. Persistent observation allows the researcher to identify what is relevant to the study and what is not (Lincoln & Guba 1985). Through persistent observation, a solo researcher can also see how students and teachers function, which groups are motivated, which groups struggle, and how the teachers interact with the students.

### Triangulation

Triangulation allows a researcher to view events from multiple perspectives. Lincoln and Guba (1985) outline several categories of triangulation, including triangulation by the use of multiple and different data, methods, investigators, and theories.

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### Peer debriefing

Peer debriefing is a process in which the investigator discusses the investigation with peers. Through peer de-briefing a solo research can explore aspects of the research that may otherwise remain only implicit (Lincoln & Guba, 1985). Peer debriefing can encourage a solo researcher to search for biases, scrutinise their hypotheses and justification for their research, discuss the direction of their research and methodological design, and to explore their feelings and emotions towards their research so that they can assess how their experience might impact upon their interpretation of the data (Lincoln & Guba, 1985).

Through the establishment of a rigorous peer debriefing process and open channels of discussion and communication with educators, a critical analysis of the observations and interpretations of the data can be achieved. As the facilitator of all of the sessions, solo researchers need to be cautious of teaching to the desired outcome and of being overly positive in their recording of observations and interpretation of the data. To maintain integrity, solo researcher should establish an ongoing process of peer debriefing with several senior researchers who could provide a critical perspective of the interpretation of the results as well as providing alternative interpretations of the data. By involving educators, such as school teachers and university lecturers, in the analysis of the results and by garnering their reflections and feedback, solo researchers can ensure that their research design is valid and viable.

Peer debriefing can also include the presentation of stages of the research at both local and international conferences. The sharing of ideas can help HDR students not only in terms of the validation of their research and the development of trustworthiness, but can also help HDR students to gain a better understating of the field of technology-enhanced learning.

### Transferability

Transferability is the extent to which the findings from one study can be applied to another (Shenton, 2004). Lincoln and Guba (1985) argue that it is the responsibility of the investigator to ensure that sufficient contextual information about the fieldwork sites is provided to enable the reader to make such a transfer. Shenton (2004) proposes that the information relating to the following six issues should be provided in the research:

a) the number of organisations taking part in the study and where they are based
b) any restrictions in the type of people who contributed data
c) the number of participants involved in the fieldwork
d) the data collection methods that were employed
e) the number and length of the data collection sessions
f) the time period over which the data were collected.

In the results this information should be provided by a HDR student to convey the boundaries of their study.

### Confirmability

Shenton (2004) describes confirmability as ‘the qualitative investigator’s comparable concern to objectivity’ (p.72). He further explains that steps must be taken to help ensure as far as possible that the findings of the research are the result of the ideas and experiences of the participants rather than the characteristics and preferences of the researcher. Miles and Huberman (1994) contend that a crucial measure for confirmability is the extent to which a researcher admits his or her own predispositions. Shenton (2004) adds that recognition of shortcomings in study’s methods and their potential effects on the research as well as the inclusion of an in-depth methodological description can allow for the integrity of research results to be scrutinised. For a HDR student, this can include outlining the limitations of the study and the researcher’s particular frame of reference. For example, a classroom teacher conducting research in a classroom may have a different interpretation of the data than an instructional designer.

## The Research Design

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The criteria to ensure reliability of the research design are outlined below.

## Micro phases

The use of micro phases or prototyping phases in design research is a strategy to ensure reliability of the design before the final field work study. As design research aims to ascertain if and why a particular intervention works in a certain context, micro research phases provide researchers with an opportunity to refine the design and to gain a more informed understanding of why an invention may (or may not) work in that context (Plomp, 2007). Micro phases involve a series of small scale design studies that result in the subsequent revaluation of the materials before the final product is used in a school-based study. The use of micro phases is part of what Plomp (2007) refers to as the prototyping stage: 'each cycle in the study is a piece of research in itself (i.e. having its research or evaluation question to be addressed with a proper research design)' (p. 25). Each phase should be presented as a separate study as there may be different research questions, population groups, data samples and methods of data analysis. This approach was used by Mafumiko (2006), who undertook a micro-scale investigation of improving the chemistry curriculum in Tanzania, and Squire (2004), who conducted three 'cases' in the use of the computer game Civilization III with different student groups in different settings in order to refine his design. Figure 2 shows the progression through Mafumiko's (2006) study and highlights the incremental progression through the phases. It is evident that there were four versions of the design prior to the final field test in the school-based study. Here, the design was scrutinised by experts and teachers to improve the materials used in the final study.

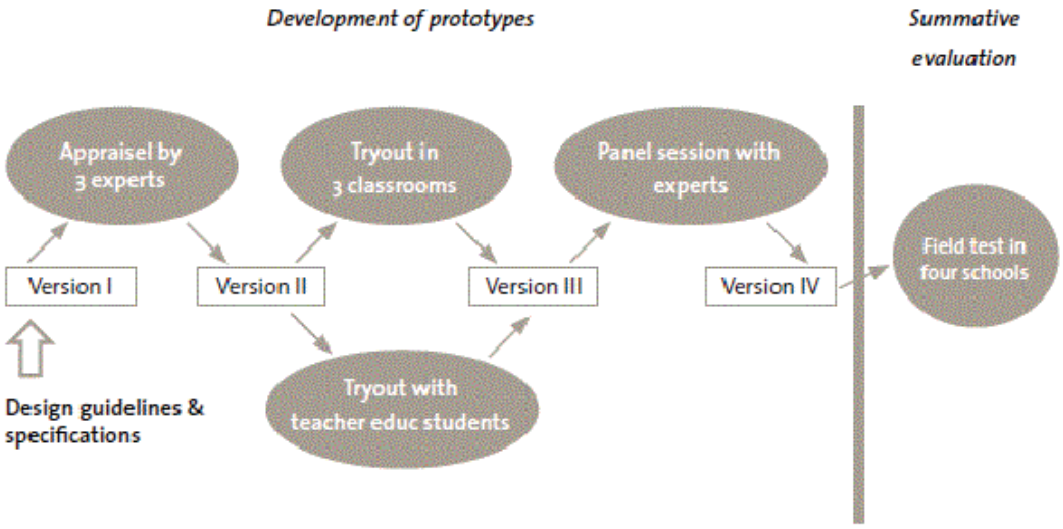


*Figure 2. Example of research design showing micro phases adapted from Mafumiko (2006) in Plomp (2007)*

One of the issues that can arise in design research by a solo investigator is the occurrence of conflicting researcher roles; that of the designer and developer, the facilitator and the evaluator of research. While playing multiple roles can be beneficial in that a researcher can understand the whole process, there are, at times, tensions between the roles. Hence, it is proposed that it is necessary for solo design researchers to implement checkpoints during the process to ensure that objectivity is maintained.

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### Expert groups

The inclusion of several expert groups throughout the study to evaluate the materials and data collection instruments (surveys, pre-and post-tests and observation schedules) and interrogate the findings provides a degree of rigour that may otherwise escape a solo researcher. As the designer and developer, solo researchers need to ensure that the instruments and materials are testing what they were meant to. This process of external review should occur prior to the initial data collection and any school-based field test. Both Mafumiko (2006) and Squire (2004) subjected their designs to the scrutiny of experts. Where possible, the data should be coded by a second researcher. The results should also be submitted as conference papers in a timely manner to maintain objectivity via a blind peer review process. As the designer and developer of the materials, this process of external and internal review maintains the integrity of the research.

### Diverse participant groups

The use of prototype phases with a range of relevant participants groups is also recommended for two reasons. As Reimann (2010) explained, it is often difficult for ethical and practical reasons to conduct lengthy studies in classroom situations. For ethical reasons, school student populations are difficult to access. School-based studies are also resource-intensive and running ongoing studies with student groups can be difficult for a solo researcher. Issues of accessibility can be mitigated by using a range of participant groups in the prototype phases. For example, Squire (2004) accessed participants in after school programs as well as classrooms. Moreover, by accessing a range of relevant participant groups, such as teachers and pre-service teachers, value can be added to a study. By conducting studies with a range of participant groups, the materials can be critically analysed prior to the final field test with a student group.

### Flexibly adaptive research design

The nature of design research necessitates adaptability on behalf of the researcher. Adaptability, according to Plomp (2007), can be ensured by the researcher being prepared to take on the role of designer, advisor and facilitator without losing sight of being a researcher. Plomp (2007) also explains that as the research takes place in a real world setting, often the wishes and needs of partners may influence the study. This influence may be more prominent in a school-based study that has curriculum and ethical requirements. Given that design research takes place in a 'real world' context and is based on iterative cycles of design and re-design resulting in ongoing changes, it is necessary to implement a planning framework. The notion of evolutionary planning is described by McKenney et al. (2006) as a planning framework that is 'responsive to field data and experiences as acceptable moments during the course of a study' (p.84).

## Discussion of small-scale interventions and design research

In a small-scale study, HDR students often hesitate to generalise their research findings within a larger educational context as they are often cautioned against overstating their findings. As Stake (1995) explains:

> It is not uncommon for case study researchers to make assertions on a relatively small database, invoking the privilege and responsibility of interpretation. To draw so much attention to interpretation may be a mistake, suggesting that case study work hastens to conclusions. Good case study is patient, reflective, willing to see another view of the case. An ethic of caution is not contradictory to an ethic of interpretation (p.12).

Hence, HDR students often make what Stake (1995) in the text *The art of case-study research* called 'petite generalisations', whereby generalisations are made within the location of the case study. Mafumiko (2006) found that using design research allows for the realisation of promising small-scale examples of interventions and the generation of methodological guidelines for the design and evaluation of such interventions. In this respect, it has been argued that it is through generalisations that patterns and their theoretical utility emerge (Barab & Squire, 2004). Moreover, it has been put

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forward that in design research the cycle of iteration and evaluation of the design may actually reduce the overstating of assertions and conclusions (Barab & Squire, 2004).

As a solo researcher, managing the large data sets that accompany each micro phase can lead to selection bias. In a thesis, large quantities of data remain unreported or excluded from the results, not because they lacked value, but simply due to the practicalities of a thesis, such as word count and the time taken to analyse large data sets. The presentation of observations and findings may be compromised by individual biases and experiences regardless of the number of check points set in place to maintain integrity. As Stake (1995) further cautions:

> We do not have adequate guides for transforming observations into assertions – yet people regularly do it ... the logical path to assertions often is apparent neither to reader nor to researchers themselves ... for assertions, we draw from understandings deep within us, understandings whose derivation may be some hidden mix of personal experience, scholarship, assertions of other researchers. It will be helpful to the reader when such leaps to conclusions are labelled as speculation or theory, but researchers often do not (pp. 9-12).

To reduce the incidence of selection bias the use of criteria, such as those outline in Table 1, may assist in ensure that the results presented by a solo HDR researcher using a design research approach are reliably and valid. On the whole, as Cobb et al. (2003) explain, the crucial determinant in a solo or team research study is that the individual or team has the expertise and skills to develop the initial design, undertake the experiment and undertake a systematic and retrospective analysis of the data.

## Conclusions

One final note on design research and the criteria presented in this paper is that, as explained in a range of papers on design research, the large data sets and the undertaking of research in an authentic context present a researcher or team or researchers with a range of challenges. These challenges may result from gaining access to classrooms, selection bias, analysing and reporting on mixed data sets. HDR students often lack the resources to conduct large scale research studies and, consequently, focus on micro studies, which may be more manageable and achievable. This does not reduce or nullify the value of these contributions to the field. However, what it does suggest is that the contributions need to be appreciated on the basis of the trustworthiness of the design and the contributions that these studies make to local educational contexts and theory building.

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## References

Amiel, T., & Reeves, T. C. (2008). Design-Based Research and Educational Technology: Rethinking Technology and the Research Agenda. Educational Technology & Society, 11(4), 29-40.

Bannan-Ritland, B. (2003). The Role of Design in Research: The Integrative Learning Design Framework. *Educational Researcher, 32*(1), 21-24.

Barab, S. A. (2006). Design-Based Research: A methodological toolkit for the learning sciences. In K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 153-169). Cambridge: Cambridge University Press.

Barab, S. A., Dodge, T., Thomas, M. K., Jackson, C., & Tuzun, H. (2007). Our Designs and the Social Agendas They Carry. *Journal of the Learning Sciences, 16*(2), 263-305.

Barab, S. A., & Squire, K. (2004). Design-Based Research: Putting a Stake in the Ground. *Journal of the Learning Sciences, 13*(1), 1 - 14.

Author Name: Shannon Kennedy-Clark
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Brown, A. L. (1992). Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings. *Journal of the Learning Sciences, 2*(2), 141 - 178.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9 -13.

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design Research: Theoretical and Methodological Issues. *Journal of the Learning Sciences, 13*(1), 15-42.

Confrey, J. (2006). The evolution of design studies as methodology. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 135-152). New York: Cambridge University Press.

Dede, C. (2004). Commentaries: If Design-Based Research is the Answer, What is the Question? A Commentary on Collins, Joseph, and Bielaczyc; diSessa and Cobb; and Fishman, Marx, Blumenthal, Krajcik, and Soloway in the JLS Special Issue on Design-Based Research. *Journal of the Learning Sciences, 13*(1), 105 - 114.

Edelson, D. C. (2002). Commentary: Design Research: What We Learn When We Engage in Design. *Journal of the Learning Sciences, 11*(1), 105 - 121.

Fishman, B., Marx, R. W., Blumenfeld, P., Krajcik, J., & Soloway, E. (2004). Creating a Framework for Research on Systemic Technology Innovations. *Journal of the Learning Sciences, 13*(1), 43 - 76.

Ketelhut, D. J., Clarke, J., & Nelson, B. (2010). The development of River City, a multi-user virtual environment-based scientific inquiry curriculum: historical and design evolutions. In M. J. Jacobson & P. Reimann (Eds.), *Designs for learning environments of the future* (pp. 89-110). New York: Springer Science + Business Media.

Ketelhut, D. J., Dede, C., Clarke, J., & Nelson, B. (2006). *A multi-user virtual environment for building higher order inquiry skills in science*. Paper presented at the American Educational Research Association. Retrieved from http://muve.gse.harvard.edu/rivercityproject/research-publications.htm

Leedy, P. D., & Ellis Ormrod, J. (2005). *Practical Research Planning and Design* (8th ed.). New Jersey: Prentice Hall.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. Beverly Hills, Calif: SAGE.

Mafumiko, F. (2006). Micro-Scale Experimentation as a Catalyst for Improving the Chemistry Curriculum in Tanzanie. University of Twente, Enschede.

McKenney, S., Nieveen, N., & van den Akker, J. (2006). Design research from the curriculum perspective. In J. Van den Akker, K. Gravemeijer, S. McKenney & N. Nieveen (Eds.), *Educational Design Research* (pp. 67-90). London: Routledge.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis* (2nd ed.). Thousand Oaks: SAGE.

Plomp, T. (2007). Educational Design Research: an introduction. In T. Plomp & N. Nieveen (Eds.), *An Introduction to Educational Design Research. Proceedings of the seminar conducted at the East China Normal University, Shangai (PR China), November 23-26, 2007* (pp. 9-33): SLO Netherlands institute for curriculum development.

Punch, K. F. (1998). *Introduction to Social Research: Quantitative and Qualitative Approaches*. London: SAGE.

Reeves, T. C., Herrington, J., & Oliver, R. (2005). Design Research: A socially responsible approach tp instructional technology research in higher education. *Journal of Computing in Higher Education, 16*(2), 97-116.

Reeves, T. (2006). Design research from a technology perspective. In J. V. D. Akker, K. Gravemeijer, S. McKenney & N. Nieveen (Eds.), Educational design research (pp. 52–66). New York: Routledge.

Reimann, P. (2010). Design-based research. In L. Markauskaite, P. Freebody & J. Irwin (Eds.), *Methodological choices and research designs for educational and social change: Linking scholarship, policy and practice* (pp. 37-50). New York: Springer

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Schoenfeld, A. H. (2009). Bridging the cultures of educational research and design. Educational Designer, 1(2). Retrieved from http://www.educationaldesigner.org/ed/volume1/issue2/article5

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22*, 63-75.

Squire, K. D. (2004). *Replaying history: Learning world history through playing "Civilization III"*. Unpublished Ph.D., Indiana University, Indiana.

Stake, R. E. (1995). *The Art of Case Study Research*. London: Sage.

The Design-Based Research Collective. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher, 32*(1), 5-8.

Wang, F., & Hannafin, M. J. (2005). Design-Based Research and Technology-Enhanced Learning Environments. *Educational Technology, Research and Development, 53*(4), 5-23.