# Design-Based Research in Child-Robot Interaction

## Bridging the gap between the intended and the implemented

Lykke B. Bertel, Dorte M. Rasmussen, Gunver Majgaard and Glenda Hannibal

Aalborg University, University College Lillebaelt, University of Southern Denmark
and University of Vienna
lbb@hum.aau.dk, dmra1@ucl.dk, gum@mmmi.dk and
glenda.moeller@univie.ac.at

## 1 Introduction

Researchers in Child-Robot Interaction (CRI) face many challenges with standardized evaluation methods in HRI, particularly related to ethical issues and questions of objectivity, reliability and replicability. Here, we argue that the *applicability* of research to actual teaching practices across educational contexts is an equally critical issue in CRI. Thus, we suggest the Design-Based Research (DBR) methodology as a way to address ethical issues in CRI as well as to increase the transfer and translation of CRI research into improved practice. Based on our experiences from two case studies; one on the application of the robot seal PARO to autism education; and one on the use of NAO in primary school, we discuss issues of evaluation in DBR and CRI.

## 2 Design-based Research

Design-Based Research (DBR) as a methodological approach to educational research aims to develop didactic designs together with practitioners to inform and improve practice. Thus, DBR is always situated in natural settings (e.g. the classroom) and the practitioner is seen as a valuable partner in identifying problems and establishing research questions. The purpose is not just to evaluate a new product or intervention, but systematically explore and refine the problems, solutions and methods while also producing design principles that can guide similar research in complex, real-world environments with emphasis on practical impact on practice [1, 2].

### 2.1 Design-Based Research in Educational Robotics

Since educational robotics (i.e. hands-on robotic kits) support a constructionist approach to learning, research within educational robotics has a tradition for including users and practitioners in the design and development through participatory innovation processes [3]. Within social robots for learning, on the other hand, a much clearer boundary is drawn between users and developers. Practitioners are usually not involved in the design and development process and limited research has been conducted on actual implementation of social robots in real-world learning environments [4].

adfa, p. 1, 2011.

We have applied the DBR-approach in two studies of social robots for learning in two different educational contexts. One long-term (3 months) case study on the use of the robot seal PARO at a school for children with autism [4] and one multiple case study on the use of the humanoid robot NAO at 10 different primary schools (more than 15 school classes from 3rd grade to high school) [5]. In both scenarios, we as researchers entered into a partnership with the practitioners (teachers, and in some cases schoolchildren) and collaborated on the design of the robot-supported didactic interventions (problems/focus, solution/materials and methods/interactions), which were then explored, evaluated and refined iteratively [4, 5].

## 3 Evaluating Child-Robot Interaction: To Prove or Improve?

DBR does not propose a fixed framework for impact measurement, which can pose a challenge to both researchers and practitioners often obliged to document a technology's or didactic design's effects on motivation, social interaction, learning etc. However, documenting an effect is not necessarily evaluating impact on practice. DBR is, in our view, a possible way to bridge the gap between the *intended* and the *implemented*. The introduction of DBR in CRI studies suggest a switch from focusing on *proving* that a social robot "works" (i.e. increases learning) to *improving* the way robot-supported didactic designs are introduced and used in practice in real-world educational contexts. In the following, we summarize some of the key points from our experiences with the DBR-approach to CRI studies:

*Co-design and knowledge sharing:* Practitioners (teachers, children and others) are valuable experts, not just as informants but also as co-designers and partners in CRI studies. The potential articulation of tacit and embedded, contextual knowledge in the process of design, implementation and improvement can support the development of not only the robot-supported didactic designs but also practice itself.

*Motivation and impact on practice:* Motivation is essential in teaching and learning and participation in the design and implementation processes in CRI studies increases practitioner's motivation and engagement – which again increases the potential of the social robot or didactic design and thus the impact on practice.

*Evaluation:* Collaborating with practice provide a much deeper understanding of the context, culture, values, individual needs and relationships, which affect the interaction, particularly when interactions are atypical or incomprehensible to those outside the domain of practice. Iterations are essential and a mixed method approach to data collection and analysis support the development of transferable design principles.

*Ethical considerations:* Many of the ethical issues in CRI are discussed on a very general level (e.g. children's vulnerability and sensitivity to simulation and deception). In DBR, teachers and children are not passive consumers of technology but powerful co-creators of technological practice. Though ethical discussions may and should still arise, DBR entails a much more dynamic, pragmatic and emphatic approach to ethics, concretizing ethical issues in relation to the context and situation at hand, e.g. the child's age, cognitive abilities, preferences and needs.

## 4 References


1. Amiel, T., & Reeves, T. C. (2008). Design-based research and educational technology: Rethinking technology and the research agenda. *Journal of Educational Technology & Society*, 11(4), 29-40.
2. Van den Akker, J., Gravemeijer, K., McKenney, S., & Nieveen, N. (Eds.). (2006). *Educational design research*. New York: Routledge.
3. Majgaard, G., Misfeldt, M., & Nielsen, J. (2011). How design-based research, action research and interaction design contributes to the development of designs for learning. *Designs for learning*, 4(2), 8-21.
4. Bertel, L. B., Rasmussen, D. M., & Christiansen, E. (2013). Robots for Real: developing a participatory design framework for implementing educational robots in real-world learning environments. In *Human-Computer Interaction–INTERACT 2013* (pp. 437-444). Springer Berlin Heidelberg.
5. Majgaard, G., & Brogaard Bertel, L. (2014). Initial phases of design-based research into the educational potentials of NAO-robots. In *Proceedings of the 2014 ACM/IEEE international conference on Human-robot interaction*. ACM.