Portraying the design research cycle: Professional development in Indian slums

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Abstract
Although para-teachers make up a substantial portion of the world's educational work force, little empirical research has been conducted on their professional development. During the iterative process of analysis, design, evaluation, and revision, design research was conducted to gain insight into desirable characteristics of a professional development program for Indian para-teachers in urban slums. The design study flanking evolution of the para-teacher professional development program helped (re)shape each cycle of implementation, and to track lasting effects on organizational climate, teacher agency and pupil learning. Because long-term, high-quality design studies in the field of education are rare, this paper focuses on the research approach and its affordances for contributing to theory-development while also capturing and speaking to the needs of practitioners.

Purpose and background
To explore how to use and apply emerging theories on professional development (PD), design studies are increasingly being used. Design studies emphasize the whole cycle of scientific inquiry, often involving sub-studies in cycles throughout the stages of problem identification, hypothesis (re)forming, solution development and testing. Design studies require interaction and collaboration among researchers, teachers, and other stakeholders. This contribution speaks to a fervent call for design researchers to share their emerging insights on how to maximize the potential and minimize the weaknesses of this powerful yet challenging approach. It does so by looking at a case-example of para-teacher processional development in Indian urban slums, in light of an existing model for conducting design research.

About design research
According to Barab and Squire (2004), design research is "a series of approaches, with the intent of producing new theories, artifacts, and practices that account for and potentially impact learning and teaching in naturalistic settings. "The field of design research has been gaining momentum, particularly in educational studies, over the last decade. In special issues of highly respected journals, the need for attention to be given to design research was demonstrated: *Educational Researcher* (2003, 31(1)), *Journal of the Learning Sciences* (2004, 13(1)); *Educational Psychologist* (2004, 39(4)). Books devoted to the topic examine design research conceptualization (van den Akker, Gravemeijer, McKenney, & Nieveen, 2006) as well as methodological options (Kelly, Lesh, & Baek, 2008; Reinking & Bradley, 2008; Richey & Klein, 2007).

From a methodological perspective, design research is considered a 'manifold enterprise' (Bell, 2004). While there is much variation in how different design researchers interpret and use the approach, an increasing degree of consensus is being reached on characteristics of design research. Wang and Hannafin (2005) describe design research as pragmatic; grounded; interactive; iterative, flexible; integrative; and contextual. According to van den Akker, McKenney &Nieveen (2006), design research may be characterized as interventionist; iterative; process-oriented; utility-oriented; and theory-oriented. In their book about design research in the domain of literacy, Reinking and Bradley (2008) delineate seven characteristics of design research: intervention centered; theoretical; goal-oriented; adaptive and iterative; transformative; methodologically inclusive and flexible; and pragmatic.

Several different models for design research have appeared in the literature. Some are more conceptual, and have been used to help describe differing sequences of steps in the design research process (cf. Ejersbo et al., 2008). Others emphasize a flexible but clear process, along with varying degrees of conceptual, or substantive, support. Reeves (2006) and McKenney and Reeves (2012) offer models that highlight the process but are more generic in nature; whereas that of McKenney, van den Akker and Nieveen (2006) is more focused on core concepts and less on the process. A model put forth by Bannan-Ritland and Baek (2008) pays attention to both process and concepts, but has not yet been widely adopted. Euler (this volume) presents a model involving six key phases in one large cycle, which can also accommodate sub-cycles (see Figure 1).

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The aforementioned publications on design research have been pivotal in garnering what has grown to be widely-held support for a research approach now considered a viable route to increasing the relevance of educational research. However, the current body of international literature contains very few in-depth examples of long-term, high-quality design research which embody the characteristics discussed above. Further, there is an extreme lack of examples demonstrating how this approach can be applied in the context of PD. This paper describes each aspect in the above model and illustrates its elements through a 5-year study on para-teacher PD, conducted in India.

About the context
Studies in India echo international findings with regard to shaping teacher PD, for example, by suggesting that teacher PD should (cf. McKenney & Thijs, 2010):
- Address concrete questions related to daily work, with a focus on instruction;
- Be ongoing and sustained (one-off workshops are doomed to fail);
- Incorporate collaborative learning strategies, such as peer coaching and review; and
- Be largely self-directed, supporting teachers in identifying their own learning needs.
Such ideas provide useful starting points for studies on para-teacher PD, but it must be recognized that para-teachers are quite different from teachers. Para-teachers generally lack any formal qualification related to teaching and learning, but nonetheless supplement regular classroom teaching in many countries, and especially in the developing world (Govinda & Josephine, 2004). Para-teachers usually come from the deprived communities in which they work, and are often better able to establish rapport with the local adults and with the children (Desai 2003; Pandey 2006). They have become recognized as valuable assets to the educational workforce in developing countries and especially in India. Very few empirical studies have been conducted on feasible and effective ways to educate these much-needed participants in the Indian educational system. The design study featured here was conducted to inform the design, implementation and evaluation of PD programs aimed at supporting para-teachers in Indian educational NGOs.

The present study was situated in an organization called Maitri, an educational NGO in India that provides educational support to children in under-served urban slums. While Maitri is active across India, this study took place in a western state of Gujarat, where Maitri implements Urban Learning Centers (ULCs) to provide remedial education for public school children. Originally Maitri implemented free remedial services for students who lagged behind in basic competencies of reading, writing and arithmetic. Later it modified its strategy and para-teachers were required to teach additional subjects including Gujarati (first language), English, Math Science, History, Geography, and Civics, up to age 14 (grade7) in a learner-centered way, as well as charge fees for their services. Maitri's decision to support para-teachers in delivering the remedial programs provided the context for this study. Through systematic research and development, this study was

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undertaken with the dual aims of: (a) developing an intervention to facilitate the PD of para-teachers in implementing learner-centered teaching strategies; and through this, (b) contribute to scientific understanding about para-teacher PD programs in settings like this one. Guided by this approach, the main question shaping evolution of PD activities for para-teachers was framed as: *What kind of professional support can help para-teachers adopt and develop teaching strategies with a learner-centered orientation?* This question was answered through a series of sub-studies, as described in the next section.

Methods
The design study on para-teacher PD took place in several phases, as shown in the aforementioned model (Figure 1). Detailed findings from this study have been reported elsewhere (Raval, 2010). Toward understanding the research approach, and its affordances for contributing to theory-development while also capturing and speaking to the needs of practitioners, the basic process is briefly described here, followed by more detailed descriptions in the findings section.

The first phase of the study featured specification of the problem. Informed by literature, this was undertaken through a learning-needs and context analysis with Maitri's para-teachers and their managers. In addition, a 'strengths, weaknesses, opportunities and threats' (SWOT) analysis was carried out to establish options and boundaries for a sustainable PD program. Based on the findings from the needs and context analysis, a second literature review was conducted to inform the design of a PD program that would speak to participant needs and also fit in the organization. This resulted in a research-based framework for design that was tailored to the context in question. The para-teacher PD program was developed and implemented in three iterations. First the main researcher facilitated a pilot program, which took place under circumstances that were slightly more favorable than usual. Based on the pilot experiences, the program was revised and adopted by the organization after a formative evaluation. During the second iteration, the main researcher was available as a resource, and co-facilitated with location managers. After the second cycle of implementation and studying the results, one last round of revisions was made to the program based on results of a formative evaluation, and it was implemented again. During the third cycle, the researcher no longer facilitated during the program. A final summative study was conducted two years later (no additional support was given in the interim) to study any long term impact of the program. The main role of formative assessment was to indicate areas of refinement, and that of summative assessment was to indicate the impact of the program. Finally, the research team reflected systematically between but also across all cycles of the design study to distill design heuristics for shaping the PD of para-teachers in similar settings.

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Findings
Specify problem
Problem specification involved development of a theoretical framework to guide the investigation. The framework involves four interrelated contextual factors considered likely to influence para-teacher learning: the (para)-teacher, the instructional setting, the organizational setting and policy. Each of these factors individually and collectively influences professional teacher learning. This framework was used to guide a needs and context analysis aimed at understanding the practical conditions likely to foster or inhibit the PD program and to frame the PD objective. Data were collected to understand the existing characteristics of each factor from the framework within Maitri, and the fostering or inhibiting influences of these characteristics on the intended para-teacher learning. Results revealed that there was a high level of motivation and commitment on the part of para-teachers towards their job which could play a crucial role in fostering PD. At the time, it also

revealed that the para-teachers had (by objective assessment and their personal assessment) substantial gaps in their knowledge and skills related to teaching. Moreover, the status of the instructional setting, organizational setting and policy reflected several challenges for future PD of para-teachers. These are presented in Table 1, below. At the end of the first sub-study, a PD objective was framed based on the learning needs experienced by para-teachers and their supervisors and actual needs which surfaced while observing classes. This objective was defined in terms of supporting para-teachers in designing and implementing systematically structured lesson-plans with learner centered strategies. The learner-centered approach here included strategies like combining group work and whole class instruction (instead of whole class alone), practical instructional activities, questions for student engagement, proactive use of class norms for disciplining as they were realistic and yet helped lead teachers away from traditional approaches towards relatively greater student engagement and learning. Such a "stepping stone" approach may not yield ideal learner-centered approaches at first sight, but can potentially lead to a successful development of teachers' capacities to implement learner-centered approaches in the future (Sullivan, 2004). Detailed information about the needs and context analysis framework and resulting findings are available (Raval, McKenney & Pieters, 2012a).

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Evaluate literature
Towards a theory-driven PD program, a design model based on a literature review was developed. It guided the design in conjunction with the findings of the needs and context analysis and the craft wisdom of those involved. The design model was inspired by critical attributes of PD, including a situated instructional focus which connects learning to actual problems of practice; ongoing and sustained rather than isolated one-shot events; a self-directed and collaborative focus. It involves tailored PD activities that are feasible and meaningful given the educational, cultural and organizational (NGO) context of para-teachers in India. The model emphasizes development of three core cyclical practices as a part of the daily routine of para-educators: lesson-planning, lesson enactment, and lesson-reflection. Each of the core activities is supported by workshops, micro-teaching and coaching, respectively. The model shows that this takes place within an organizational context that must first create the necessary pre-conditions (e.g. sufficient time to prepare for teaching tasks, or support of leaders and peers) for the activities to flourish. Additional information about the design model is available (Raval, McKenney & Pieters, 2010).

Prototype 1: Design
The design model described above served to guide the development of the first prototype: a PD program for Maitri's para-teachers. The main researcher first piloted the program (as facilitator, also consulting with the program-leader), in which para-teachers were introduced to the core activities of planning, enactment, and reflection of daily lessons using tailor-made templates for lesson-planning and reflection. Supportive strategies were also implemented. This study took place during a summer vacation while para-teachers taught an optional subject, with less time constraints and reduced pressure of accountability to parents, so only minor organizational changes were required.

Prototype 1: Formative evaluation
A formative evaluation was conducted to determine the practicality and potential of the intervention to meet its goals. This helped identify elements to leave untouched, as well as those to

refinements in PD program before institutionalizing it. The study was shaped by the following questions and data collection methods:

1. How did the para-teachers experience the professional development interventions?
   - Participant Interviews
2. What lesson-planning skills did para-teachers acquire?
   - Document Reviews of Lesson Plans
   - Participant Interviews
3. What are the perceptions about changes in classroom enactment?
   - Cluster head interviews
   - Participant interviews

Of the 30 participants in the PD program, nine para-teachers were respondents. The interview data were categorized based on predefined themes and new themes or recurrent patterns of meaning (Merriam, 1998). Document review of lesson plan was done quantitatively. From the 20 lesson plans created during the four weeks, three from each week were selected at random for a total of 12 lesson plans per person. Altogether 108 lesson plans were analyzed. Four parameters were developed to analyze the plans: completeness, accuracy, appropriateness and detail. Answers to each question in the planning tool were coded according to these parameters. A code "y" was allotted when the question fulfilled the parameter and "n" when it did not fulfill the parameter. Scores, based on percentages of "y" codes, were used to rank participant performance on each parameter and each question. Performance scores between 0 to 33 percent were considered low, 34 to 66 percent was considered moderate and scores above 66 percent were considered high. A strong inter-coder agreement (Kappa Coefficient=0.86) was obtained after comparing one-third of the lesson plans coded by 2 coders.

The study concluded that the participants' first PD experience was positive and had led to a clear shift towards well-planned lessons and learner-centered strategies. Respondents cited favorable attributes of the program like demonstrations, micro-teaching, joint planning, reflection and the immediate ongoing support for implementation. The study also concluded that para-teachers had gained high proficiency in systematic lesson-planning with learner-centered strategies, through high mean scores achieved in 7 out of 11 aspects of lesson planning (e.g., introductory activity; link with previous day's lesson; lesson objective; formation of groups; directions for group activity). Classroom enactment changes towards well-structured teaching with a learner-centered orientation were also perceived by the para-teachers and their cluster heads especially in matters like framing lesson objective; time-planning; implementing learning activity step with appropriate materials and differentiation through group work; disciplining strategies like classroom norms. One difficulty experienced was in planning for and implementing pupil management strategies (i.e. discipline, facilitating pupil behavior for learning). The organization experienced the pilot as successful, which helped pave the way for a second phase of PD activities. The detailed pilot study is available (Raval, McKenney & Pieters, 2012b).

Prototype 2: Design
After the pilot ascertained that the PD program was useful, the second phase sought to institutionalize the core cycle and explore its value during the regular school term. The core and supportive strategies were also modified based on the findings of the formative evaluation. For example, the lesson planning and reflection tools were fine-tuned (shortened, simplified) on the basis on participant reactions in the pilot study. Workshops included clarification on those aspects of lesson planning which were found to be weak based on the review of lesson-plans of the pilot phase. The institutionalization agenda necessitated changes in organizational conditions for

bolstering core and supportive activities. These were led by location managers with help from the researcher (e.g. through a workshop for helping managers determine necessary institutional changes). Policies and practices that compromised teaching-learning quality in the centers (e.g., fee-based enrolment) were suitably modified; and the initial planning and reflection tools for the para-teachers were revised based on the findings from the pilot. With some modifications, core and supportive strategies were implemented with co-facilitation by the location managers and the researcher.

Prototype 2: Formative evaluation
The formative evaluation for this phase of institutionalization aimed at assessing the extent of systematic learner-centered orientation in lesson-planning and enactment; other kinds of PD gains experienced; and the perceived role of changed organizational conditions in supporting or hindering PD. The nine para-teachers from the pilot were respondents in the institutionalization sub-study. Questions and data collection methods in this study were:
1. To what extent did participants' lesson-planning reflect a systematic learner-centered approach?
   • Document Review of Lesson Plans
   • Participant interviews
2. In what ways did the para-teachers' enactment reflect a well-structured learner-centered approach?
   • Classroom observations
   • Participant interviews
3. What other kinds of professional development gains did participants experience?
   • Participant interviews
   • Cluster Head Interviews
4. What role did the (changed) organizational • conditions play in supporting and/or hindering the PD process?
   • Participant interviews
   • Cluster Head Interviews

Data for interviews and lesson plans were analyzed as discussed in sub-study. Classroom observation data were collected through a structured observation tool, containing sections and items related to basic teaching skills required for well-structured enactment and a learner-centered environment was used for classroom observations. It comprised 39 items, divided across 1) Preparation for the class, 2) Introduction of the main lesson, 3) Teachers' role in facilitating group activity, 4) Students' role in the group process, and 5) Conclusion of the lesson. Four observations were conducted for each participant, with a total of 36 observations over 4 weeks. For each item, the observer could put a 'yes', 'no' or 'not applicable'. A mean score was obtained for each of the sections on the number of 'yes' responses. Performance scores between 0 to 33 percent were considered low, 34 to 66 percent was considered moderate and scores above 66 percent were considered high.

Lesson planning scores were high and moderate for all. Enactment scores were high or moderate for all sections except 'lesson conclusion'. The study also concluded that the bottom-up manner through which the organizational changes had been introduced, had contributed to a high level of ownership even on the part of cluster-heads to take up an educational leadership rather than administrative role within their clusters. The detailed institutionalization study is available (Raval, McKenney & Pieters, 2011).

Final version: Design

In the third and final phase, the central facilitation role was withdrawn and the implementation of the core PD activities was fully left to the location managers and para-teachers. The decision to withdraw central facilitation was based on the findings of the second formative evaluation which implied that the para-teachers were reasonably proficient in their lesson planning, and the location managers were prepared to fully support the core activities. The para-teachers continued to use refined templates for daily lesson planning and reflection, with coaching from location managers. At the beginning of the phase, workshops on subject matter difficulties identified in the previous phase, or new concepts relevant in the third phase were conducted, so that they planning could be guided by the new understanding. Para-teachers self-organized themselves for the micro-teaching sessions with the help of their managers.

Final version: Summative evaluation
The final phase of the PD program was assessed through a summative study aimed to ascertain whether the PD program yielded desired effects (retention or improvement of skills learned in the previous two programs) even when facilitation support was withdrawn. It also assessed pupil learning achievement. The findings would be used for summative purposes: to enable the organization to make future decisions about continuing the intervention and scaling it.

1. To what extent did the participants retain or improve the previously gained skill of designing well-structured lesson plans with learner-centered strategies?
   - Document Review of Lesson Plans
   - Participant interviews
2. To what extent did participants retain or improve in the use of a well-structured learner-centered approach during enactment?
   - Classroom observations
   - Participant interviews
3. What kinds of pupil learning outcomes have been achieved?
   - Subject-matter test

The nine respondents from previous evaluations continued as respondents as far as lesson-planning and enactment effects were concerned. Pupil learning data was also collected from other para-teachers who had not been part of the earlier studies, but participated in the PD activities.

The lesson plan review and classroom observation data were collected and analyzed as explained in the earlier sub-studies. The subject-matter test administered was a 25 mark test on environment science (EVS) relating to four main concepts of sun, air, earth and water. It had a mixed set of objective (e.g. true/false) and short-answer questions (e.g. fill-in-the-blank) questions. Test scores were analyzed in terms of the difference between the pre-test and post-test scores. Effect size was calculated for each class. Through linear regression, the predictive value of pre-test over post-test scores was measured. Correlation of pre-test scores with learning gain was also calculated. Pupil learning outcomes of the nine (observed) teachers were also compared through a T-test with the pupil learning outcomes of the remaining 16 teachers who participated in the professional development but were not tracked. This was done to examine any potential influence of a Hawthorne effect on the performance of the nine teachers who were aware that work was being appraised.

Lesson planning scores obtained in the previous studies either improved or were retained by participants. Similarly, lesson enactment scores improved, even in for the section of lesson conclusion where scores were low for most participants in the previous sub-study. Large effect sizes reflected a high pupil learning gains. No differences were found between pupil scores of teacher

respondents who had been tracked in the previous sub-studies and those of new para-teachers involved in the summative study, implying that PD program effects were well distributed across the NGO and not limited only to the para-teachers who were observed throughout the previous studies. These outcomes led the organization to continue with the PD program. The detailed summative evaluation is available (Raval, McKenney & Pieters, under review).

Final version: Impact evaluation
Two years after external support was withdrawn a study was carried out to assess whether and to what extent the PD program yielded long-term impact. Long-term impact was studied in terms of (a) the existing status of professional learning opportunities within Maitri; (b) quality of teaching practices; (c) pupil learning outcomes; and (d) Maitri's capacity for organizational learning to support the PD of its para-teachers.

The impact study identified a long term positive impact of the PD program. It revealed that the core routine of daily planning, enactment and reflection, introduced in the earlier PD program was fully retained. Specific learner-centered practices attempted earlier and successfully evidenced in earlier studies were retained. There was substantial improvement in both the retention of pupils, and learning achievement. Finally, the organizational changes during early PD efforts had evolved further, and included: more horizontal organizational structures, participatory leadership, greater trust and collaboration between staff members, increase in greater agency and initiative amongst para-teachers and location managers and systems promoting autonomous data-driven decision-making (Raval, 2010).

Design principles
As indicated earlier, design research strives to inform the design and development of interventions while also contributing to scientific understanding. Reflecting on the findings from the study in light of relevant literature, two sets of design heuristics have been distilled to inform the PD of un-(der) trained teachers with similar goals in poorly resourced contexts. One set of guidelines is substantive, describing salient characteristics of professional development that have emerged as desirable over the course of the study. The other set is procedural, indicating useful ways of implementing PD programs like this one, focusing on procedures that contribute to the effectiveness of the program. Since the full sets of heuristics would be beyond the scope of this paper, we report one example from each set. The full set is available elsewhere (Raval, 2010).

The substantive design guidelines describe five main characteristics of PD: guided by,(a) individual as well as contextual (organizational) requirements; (b) an instructional focus; (c) realistic choices; (d) attributes of teacher leaning and (e) a systemic approach. For each of these themes, the heuristic set presents relevant theoretical and empirical evidence (second and third columns in Table 3, below) which lead to the specific substantive design guidelines in the fourth column. For example, the first theme points to the role of individual and organizational requirements that influence the PD agenda. The table cites ideas from previous research (Kubistskey & Fishman, 2005; Loucks-Horseley, 1998) and empirical data from the analysis sub-study, conducted to assess the needs and contextual requirements to design the PD program. Both these validate the main substantive design guideline that plans about PD must be informed by perceived learning needs of teachers, the actual status of their classroom practices and characteristics of their work context (e.g. for organizational factors).

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The procedural heuristics suggest that PD should involve, (a) promoting the plan-enact-reflect cycle; (b) supporting the plan, enact and reflect cycle; (c) use of templates to scaffold planning and reflection; (d) role of teacher-heads in designing and implementing PD activities; and (e) careful implementation of changes in the organizational conditions. Like in the table on the substantive guidelines, theoretical and empirical supports that lead to procedural design guidelines are also presented. For example, the study recommends that promoting the plan-enact reflect cycle through daily lesson-planning and reflection is desirable to support teacher learning. This design guideline is generated based on theory, (E. A. Davis & Krajcik, 2005; Raval, 2011) as well as empirical evidence that indicated how lesson-planning and reflection actually strengthened para-teacher learning. An excerpt from the procedural heuristics set is given in Table 4.

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Discussion

Design-based Research (DBR) was found to be uniquely suitable for the dual focus of this study. Several contextual factors increased the already steep challenge of designing professional support for this group, and the limited theoretical and empirical base from which to draw upon rendered it a more daunting endeavor. This approach was flexible enough to evolve alongside insights from each cycle, while maintaining focus on the long term goal of the intervention and of producing knowledge that could be valuable to an audience beyond Maitri staff alone. The direct benefits notwithstanding, this approach afforded some opportunities, and challenges. We discuss these next.

Inviting collaboration of different stakeholders

This study helped build trust and solidarity of purpose between the researcher and the program team, by locating the research objective (of creating new knowledge) within real problems of practice and not despite them. Collaboration was effective because everyone had a specific role in the design process. Location managers were chief designers and critical decision-makers; their decisions were informed by reflections, suggestions and critiques from supervisors and para-teachers. The researcher was the facilitator and coach. A reflection on the whole approach by one of the management members illustrates this positive aspect of the approach, "*I have often encountered a feeling that our fuzzy ground realities are almost a botheration and a hindrance to the researchers in seeking their objective, as if it compromises their quest, as if they have to come and first clean up my kitchen to be able to work in it, and that often leaves us practitioners feeling undermined and in an unequal position with them; but this experience truly put us on an equal platform*".

Institutional capacity building

While the researcher gained new knowledge about educational practice, this study also helped generate institutional learning for the participating organization. Like in several other studies (c.f. Kuiper, Nieveen & Visscher-Voerman, 2003), participants in Maitri, learned to make more data-informed decisions as compared to earlier when their decisions were predominantly intuitive and unsystematic. This was because design research engages participants in the practice of taking implicit design elements, making them explicit (Edelson, 2002), and refining them through systematic inquiry. Management members and para-teachers learned to,

- question their assumption that all learning happens through training;
- afford proper time and systematic procedures to define the problem;
- use empirical data to assess the quality of implementation;
- use multiple sources of data so that what they learn about ground reality is not biased or incomplete;
- anticipate dilution in implementation and so plan for implementation support;

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- value collaboration as essential for decisions.

Multiple roles
The researcher combined multiple roles throughout these studies – that of, facilitator, (co)designer and researcher, which was advantageous any many ways. As a co-designer and facilitator the researcher had a direct impact on practice through development of design solutions that were both theoretically viable and responsive to ground realities. As a member of management the researcher had an 'insider' view of the organizational reality. This helped the researcher influence the integration of design and data collection activities seamlessly into the ongoing program strategy development and program evaluation.

However, two substantial threats to the study's rigor must also be acknowledged. First, the researcher's position in the organization made it difficult to ascertain how genuine participant reactions actually were. Attempts were made to mitigate socially-desirable responses by promoting collaborative decision making, especially encouraging authentic expression of disagreements or reservations and dialogue to resolve the differences. Second, the researcher's biases and influence of prior knowledge about the individual participants was constantly minimized through data triangulation.

Over-simplification of understanding about DBR
In this study, the management of the organization was drawn to the potential of DBR because it takes place in authentic settings. However, gaining consensus was difficult while judging whether a situation was a rich design and research opportunity or a threat to rigor and quality. For instance, in the first two years, research and development activities could not take off due to unstable project conditions such as erratic changes in para-teachers' roles which made it difficult to identify a group of para-teachers as stable participants in the study. However, the head of the management team expected that the research and development activities could be taken up under any amount of instability, as design research was expected to take into account authentic settings, and in this case, the 'perceived instability 'was the natural authentic situation. It took a long time and several dialogues to arrive at the understanding that such an unstable situation was not only unsuitable for rigorous research, but also for designing lasting and effective PD activities.

Advancing scientific research
This study may stimulate dialogue to advance scientific understanding about para-teacher professional development. First, the research has yielded relevant and usable design principles and findings for educational scientists who are interested in studying and advancing the status of para-teacher professional development. Second, the study is ecologically valid; when the additional reporting mentioned is also referred to, the rich descriptions of organizational conditions and the professional development interventions, make it possible to replicate and/or adapt this intervention in comparable settings. Third, this investigation addresses criticism about the low level of training of these highly motivated teachers, and helps shift the debate from whether or not to employ para-teachers to how the capacities of para-teachers can be enhanced. Though this debate has been ongoing among academic communities especially in India and other non-industrialized countries, it is beginning to surface more broadly as well (e.g. Chudgar, Chandra & Razzaque, 2014). In addition, through the use of DBR, this study models an approach which makes it possible to bridge the gap between practice and research; to the mutual benefit of each.

Closing remarks
As stated previously, a design research approach was used to gain insight into desirable program characteristics, implementation strategies and the forms of support that would be preferable while also feasible. This design study soundly meets the dual goals of serving both scientific and practical

needs, while also evidencing the characteristics of design research. Specifically, organized below according to the set offered by Reinking and Bradley (2008), this study is:

- *Intervention-centered:* Having a positive impact on para-teacher learning was central to the initiative, which is evidenced in the form of improved para-teacher capacities throughout the study.
- *Theoretical:* The program development was informed by empirical findings and theoretical work; it contributes to theory building about para-teacher PD in NGOs; especially in the form of design principles.
- *Goal-oriented:* This study explores how to support the PD of an un-(der)qualified but essential population in the teaching force (especially in developing countries): para-teachers.
- *Adaptive and iterative:* The tools and supports have evolved in light of the experiences and research findings of the needs and context analysis and formative evaluation. For example, the formative evaluation of the pilot phase led to a substantial simplification of the tools based on the document review and reflections during interview; focus of workshops was determined based on difficulties reflected in the findings; the organizational conditions modified in the institutionalization phase were guided by the organizational status reflected in the context analysis; the central facilitation was withdrawn as findings from the second formative study implied that the para-teachers and location managers were competent enough to continue autonomously.
- *Transformative:* The intervention stimulates new practices in remedial classrooms, as well as in the nature of organizational activities and conditions which are conducive to good quality professional development.
- *Methodologically inclusive and flexible:* Across the cycles, qualitative and quantitative data were collected; data source decisions were influenced by contextual opportunities and constraints.
- *Pragmatic*: Research, development and implementation efforts were driven by the desire to achieve an effective, sustainable, scalable intervention, and to derive *usable* knowledge. For example, the study introduced new learner-centered strategies based on what was feasible for the para-teachers to adopt and sustain and still yield improvements in classroom learning; it necessitated (and explicated) key organizational changes which were necessary to institutionalize the core and supportive strategies.

This paper speaks to the need for more examples of useful long-term design research in the field of education in general and PD in particular. Based on the experience from this and other studies, we remain optimistic about the potential of design research to contribute to scientific understanding through robust research while also informing the development of interventions on the ground. This approach is useful in a range of contexts, where solutions are needed to complex problems and new scientific understanding is needed to address them.

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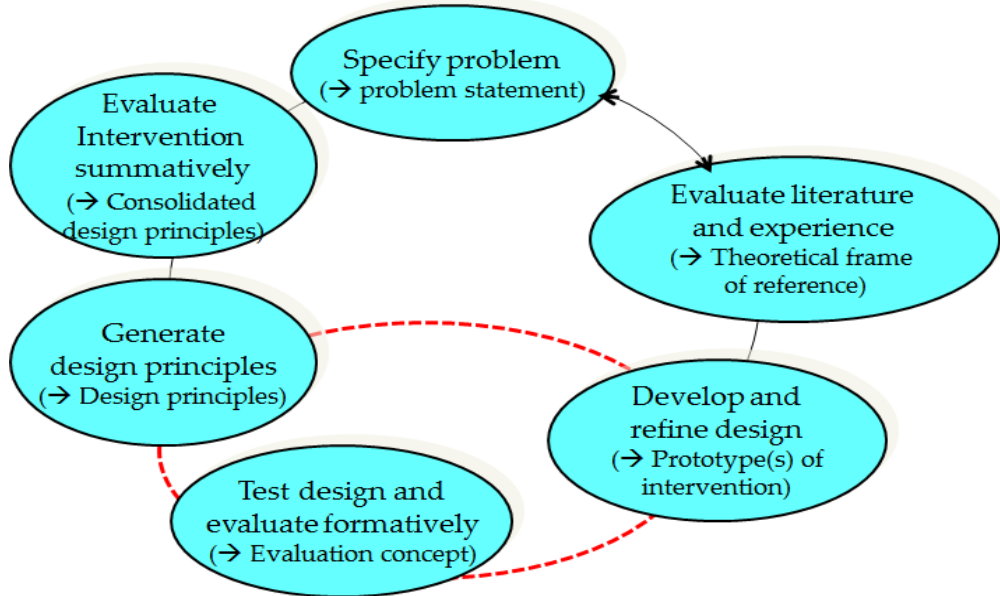
Figures and Tables (one per page)

Figure 1: Research and development cycles in the design research context (Euler, this volume)

Method \ Phase	Specify problem	Evaluate literature	Develop design	Formative evaluation	Generate principles	Summative evaluation
Management interviews	▓			▓		▓
Para-teacher interviews	▓			▓		▓
Classroom observations	▓			▓		▓
Literature review	▓	▓	▓		▓	
Project team discussion	▓	▓	▓		▓	
Document review				▓	▓	
Self-reporting				▓		▓
Pupil tests(pre/post)				▓		▓

Table 1: Methods used in each phase of the para-teacher study

Para-teacher characteristics	1. Lack of basic teaching skills to make enactment well-structured and coherent 2. Lack of learner-centered skills
Institutional characteristics (classroom composition; teaching strategies)	1. Large, heterogeneous classrooms with children from pre-school to grade 7 2. Older children with lower attainment levels than their actual grade-level curricular competencies would imply 3. Coping strategies involved inefficient individual teaching
Organizational characteristics (time and opportunity for professional learning; curricular framework; leadership)	1. 2-3 classes a day, marketing for collecting fees; no daily time to prepare for teaching 2. Professional support only in marketing strategies to increase fees 3. Lack of overall coherent curriculum to define 'what, when and how' to teach 4. Cluster head role only as administrator
Policy influences (mandates/strategies for enrolling students; curriculum expectations and academic term duration)	1. To enroll any child willing to pay fees towards fulfilling revenue targets for each month, and not based on learning requirements 2. To teach grade-specific curriculum to different students because of parental pressure, although their actual attainment was several grades lower 3. One academic term for three months, new children enrolled with each term 4. To enroll new children during a term to prevent losses in fee totals, leading to unstable student population

Table 2: Summary of needs and context analysis findings from Raval, 2010

Characteristics of professional development (PD)	Theoretical Support	Empirical Support	Substantive Design guidelines
Guided by individual as well as contextual (organizational) requirements	PD should be informed by specific needs of the participants (Kubistskey & Fishman, 2005); that is, existing knowledge and beliefs of teachers as well as the context (Loucks-Horseley, 1998)	Learning requirements of para-educators were identified (e.g. working with heterogeneous classes) and enactment gaps identified in practice (incoherent teaching) Contextual characteristics, especially organizational constraints which potentially had substantial influence on professional development, were identified	▪ Define individual learning requirements based on what teachers express as well as what their actual classroom practices reveal. ▪ Identify strengths and weaknesses of the local context , e.g. organizational factors, that could impact teacher learning
	During PD, central importance to learning processes of teachers and the particular curricular and school contexts in which professional development takes place (Penuel, et al., 2007)	Core and supportive strategies addressed individual learning needs in different ways and organizational changes played an important role in supporting para-teacher learning	▪ Aim to (re)design necessary learning activities as well as meet (contextual) organizational requirements necessary

Table 3. Excerpt from substantive heuristic set found in Raval, 2010

Procedures during professional development	Theoretical support	Empirical support	Procedural design guidelines
Promoting plan-enact-reflect cycle	Lesson planning, enactment and reflection are powerful opportunities for learning (Raval, et al., in press); teacher learning is situated in classroom instruction, planning, lesson modification, assessment (Davis & Krajcik, 2005)	The core activities led to improved lesson planning and enactment skills	- Use lesson-planning and lesson-reflection on daily enactment to support implementation of learner-centered materials

Table 4. Excerpt from procedural heuristic set found in Raval, 2010