A FRAMEWORK FOR INTEGRATED PROFESSIONAL DEVELOPMENT

Whether you are training a junior researcher or working with a seasoned teacher, an appropriate methodological framework offers an ideal environment in which to conduct a program of professional development activities. The framework described here provides a research setting allowing junior through experienced teachers and researchers to act in a variety of project management roles and perform a range of research activities. This article shows how a scaleable robust and flexible research framework is constructed by combining elements from Grounded Theory, Phenomenology and Action Research. Additionally, an administrative framework based upon the three-level teaching experiment of Lesh and Kelly is integrated to form a responsive, manageable research and professional development environment. We describe an implementation of the framework in a cognitive apprenticeship training program for discipline-based graduate educational researchers at a large research university.

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Introduction

An integrated professional development strategy is an essential component of all successful organizations. An integral component of a student's professional development is the opportunity to participate in a range of research activities and work in collaboration - both as a mentor and a junior researcher. An integral component of a teacher's professional development is the opportunity to participate in a variety of educational research activities. This paper describes a framework in which we frame the majority of its educational and research programs.

Research Elements

Three research methods: Grounded Theory, Phenomenology and Action Research together provide a robust flexible framework to perform parallel tasks utilizing a range of research and analysis tools. Each methodology imports a unique set of principles and assumptions; therefore each component is kept separate during data collection and analysis. A distinct advantage of this segregation is that as beginning graduate students are trained in each methodology they can begin to actively participate across projects and contextualize the methodology within several different research settings.

Grounded Theory

We adopt the grounded theory perspective by Strauss and Corbin. (1998). This hypothesis-free approach encourages the researcher to collect, analyze and compare data iteratively from multiple sources and perspectives to identify underlying relationships from which a working hypothesis emerges. We utilize the grounded theory approach in three ways. 1) In a Preliminary Study it can be used to design a research plan; 2) in the Primary Research Stream it provides control and guidance and helps develop a theory of instructional design within the context of study; and 3) in the Secondary Research Stream it provides the platform within Stage 1 of the research to inform and generate a set of teaching interview protocols.

Phenomenology

Phenomenology is not a research methodology per se, however, several practitioners (van Manen, 1990) have developed analytical strategies that allow for its practical applications. We have adopted it for Stages 2 and 3 in the Secondary Research stream. Generally we introduce and use Colaizzi's (1978) seven steps of phenomenological analysis to reduce collected data from the teaching interviews and action research activities.

Action Research

Action research (Holloway, 1997) is a circular process that involves planning and executing interventions to produce change in the setting under study and evaluate the impact of change. Generally we adopt Lewin's (1946) original action research methodology both as a research tool in feeding data in Stage 3 upstream to the grounded theory backbone and as professional development for researchers and teachers.

Triangulation

To maintain validity three types of triangulation by Denzin (1989) are explicitly incorporated.

Administrative Framework

To provide an overarching administrative framework a three-level teaching experiment based on the ideas of Lesh and Kelly was adapted. (Lesh & Kelly, 2000) The framework provides a shared design that allows for coordination from a small single site research team up to multiple researchers across multiple sites and has been used extensively in major projects. While Lesh and Kelly (2000) utilize an action research methodology we utilize a grounded theory approach. The main principle adopted from their multi-tiered teaching experiment is the evolving interacting sequences of modeling cycles. The combination (Fig. 1) of the three-tiered administrative framework and the grounded theory backbone provides internal communication between levels and external dissemination to interdisciplinary forums.

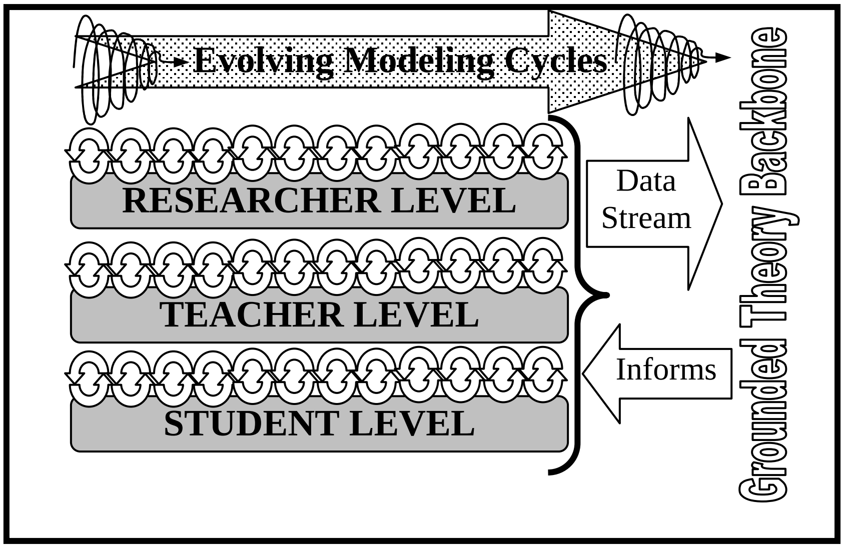

Figure 1: Administrative Framework

Research Framework

The research elements are integrated into a multi-methodological framework comprising two streams (Fig. 2) complementing the Administrative Framework. The Primary Stream utilizes a grounded theory approach and provides the project backbone. The Secondary Stream incorporates a three-stage multi-methodological approach, serving as a data source to the Primary Stream and a development and testing platform for materials.

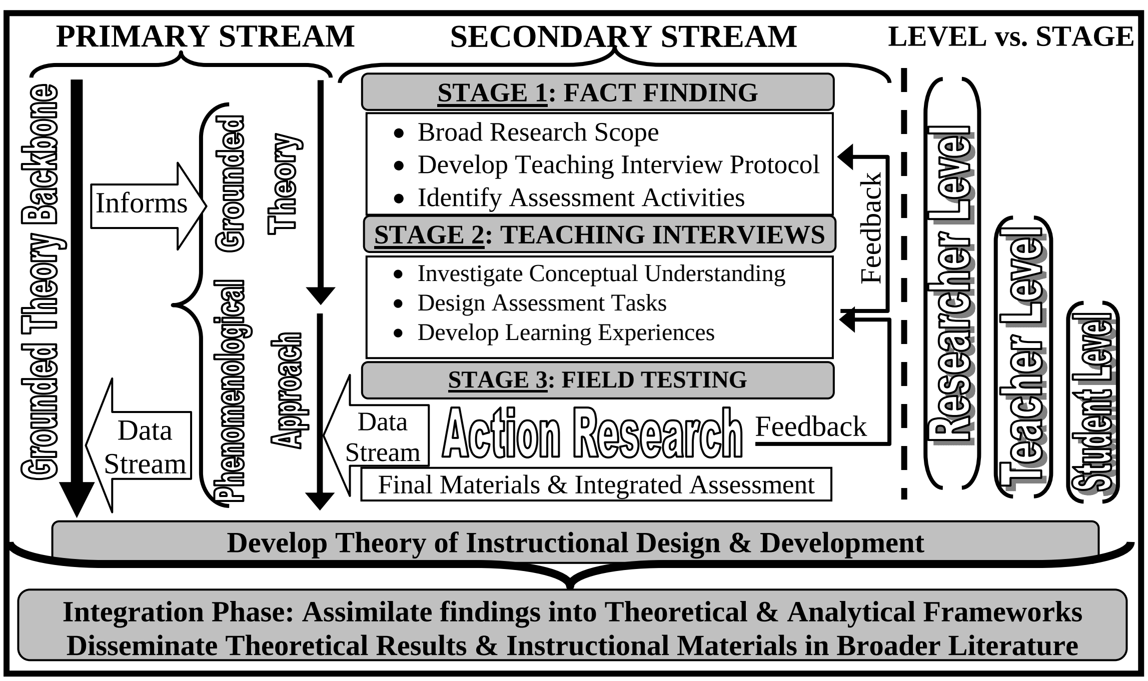

Figure 2: Research Framework

Primary Research Stream – Grounded Theory Backbone

The senior project personnel would manage and monitor the overall project from the context of the grounded theory backbone. Thus, in addition to generating theory for the project the grounded theory methodology is adapted to provide project management. From a research perspective the grounded theory methodology provides a recursive process which allows the research team to formulate, test, modify, review, discard and develop many provisional hypotheses in the context of the collected data. This process enhances the team's theoretical sensitivity by providing timely information to the Primary and Secondary Research Stream activities.

Secondary Research Stream

The Secondary Stream incorporates a three-stage multi-methodological approach and serves as the main data source to the Primary Research Stream. The aim of the Secondary Research Stream is to probe conceptual development and produce instructional materials. The stream allows researchers, teachers and students to operate within a flexible and responsive research environment.

> *Stage 1: Fact Finding*: The fact finding stage utilizes grounded theory to cast a wide net to collect data and identify key issues faced by teachers and students with regards to the investigation. Data should be gathered from a wide variety of sources including literature reviews, interviews, surveys, observations and any other appropriate source. This broad fact finding mission aims to identify specific concepts relevant to investigation. From these results researchers can design appropriate teaching interview protocols that include self-contained learning experiences and formative assessment tasks in preparation for Stage 2.
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> *Stage 2: Teaching Interviews*: The teaching interview (Stage 2 in Fig. 2) is the primary research tool to explore conceptual development and develop instructional materials. The topic for the teaching interview is determined from the grounded theory analysis of Stage 1. The teaching interview is an adaptation of the teaching experiment used in mathematics education action research. (Steffe & Thompson, 2000) Several physics education researchers (Komorek & Duit, 2004) have also used this methodology. We used the teaching interview developed by Engelhardt. (Engelhardt, Corpuz, Ozimek, & Rebello, 2003) The teaching interview includes multiple teaching episodes with individual or groups of students. The researcher is simultaneously an interviewer and teacher in a mock instructional setting that employs novel pedagogical strategies
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> *Stage 3: Field-Testing*: Action research projects are spawned to field test the instructional materials. The 'instructional module' is often adapted to fit the existing course format ranging from a full-blown lab experiment, short lecture demo or web-based homework. Field testing continues under the umbrella of the phenomenological approach. Targeted settings use surveys, interviews, videotape analysis and observational protocols similar to Maor (2000) to code students' interactions and sense-making. Learning assessments developed in Stage 2 are

also field-tested and surveys are used to gauge the user-friendliness of the materials and adaptability to various instructional settings. The administrative framework (Fig. 2) ensures that teachers have primary ownership of the action research while researchers serve as observers and support persons.

Data Collection & Analysis

Teaching interviews are videotaped, transcribed, coded and analyzed using three layers of analysis.

Phenomenographic Analysis (Marton, 1986)

Categories for coding interactions are not determined a priori but emerge from the analysis of the responses and are thus are based on students' ideas rather than researchers' preconceptions. This protocol helps the researcher establish a cross-case mega-matrix. (Miles & Huberman, 1994) An 80% inter-rater reliability and 90% intra-rater reliability is met.

Thematic Analysis (Bogdan & Bilken, 1998)

Themes emerge from various phenomenographic categories in the cross-case mega-matrix as well as the observer's field notes and reflections. Inter-rater reliability benchmarks (above) are met between researchers who compare their emergent themes.

Interaction Analysis

We adapt the methods used to assess one-on-one tutoring (Chi, Siler, Jeong, Yamaguchi, & Hausmann, 2001) to analyze the ways in which students interact with the instructional materials, teacher-researcher and each other to construct understanding using these educational materials.

These analyses guide the evolving teaching interview through successive iterations until it converges on a model of student understanding. The assessment tasks and learning experiences emerge from this iterative process. As per Wiggins and McTighe's (1998) "backward" design approach, the assessment tasks are designed prior to the learning experiences that integrate hands-on activities and computer simulations. These instructional materials, when deemed ready for field-testing in consultation with the Primary Stream, are transferred into Stage 3.

A Training Program for Graduate Researchers

Challenge

One of the main challenges facing the growing number of discipline-based educational research programs is the training of graduate students. These programs that are housed in science departments often receive a majority of students who possess a strong background in the scientific discipline, but seldom have adequate preparation in education or pedagogy. Many incoming students have completed their undergraduate education abroad and are unfamiliar with U.S. educational systems and culture. The programs train students who are pursuing Ph.D.s in the scientific discipline with an emphasis in pedagogy or Science Education with a specialization in the discipline. We also prepare students with a diverse set of professional goals. Some of our graduates seek future postdoctoral and faculty positions in science departments, while others seek positions in colleges of education. Thus, we need a flexible professional development program that addresses these diverse needs.

Relevance to Framework

The framework provides an iterative process which interconnects the development of students' conceptual models with the models of learning constructed by the teacher and in turn with the model of teaching constructed by the researcher. Although our audience did not include practicing teachers per se, most of our graduate students had experience as teaching assistants and these experiences contributed to their professional development as educational researchers. The framework also helped us realize that our graduate students must be involved as apprentices in a 'real' research project where they would interact with real students. So, we created a project which would provide a common context in which they could all participate.

Implementation

We put together a training program in which all graduate students would work from start to finish on a single research project to help contextualize their knowledge of various research methodologies, increase their theoretical sensitivity and provide them with a reference to reflect upon their own research project.

> *How does one do educational research?* At the first meeting we asked the graduate students a very broad question: "How do you do educational research?" The question revealed that students had yet to see the big picture and were focusing on the details. Therefore, we decided to scaffold the construction of their ideas by asking them to design a research project that investigated student understanding of everyday electrical devices.

> *Generating Themes, Topics and Questions*: During the first week students were asked to think individually and generate lists of ideas that they would explore within the realm of electrical devices. Particularly, they were asked to generate a list of themes, topics and possible questions that they would ask interview participants. They were deliberately asked to "think broadly" and "cast a wide net" without explicitly using the grounded approach.

> *Narrowing the Focus*: Students met during the second week to share their ideas in a large group and collapse the themes, topics and questions into a combined list. For the first time, they had begun thinking past the issues pertaining to the physics of the device and generated ideas that also addressed the societal and cultural aspects.

Designing and Conducting Interviews: For the next two weeks, students first constructed their own set of interview questions that would help identify a set of everyday electrical devices that would serve as the focus of the project in the future. They then formed pairs and interviewed undergraduate participants who were currently enrolled in algebra-based introductory physics. During each interview, one student in each pair interviewed the undergraduate and the other student observed the process and took field notes. They then switched roles. At the end of this period all students met together and critiqued their partner's interview in presence of the larger group.

Transcript Preparation and Analysis: Concurrently with the aforementioned step of designing, conducting and critiquing interviews, students also transcribed their respective interviews and tabulated their transcript which included a personal log, an analytical log and coding. Students coded and critiqued each others' transcripts.

Research Project Critique: Having completed the important steps in their own mini research project that explored everyday electrical devices, students were asked to critique a research project plan prepared by one of the authors based on what they had learned in their own mini-project. Thus, they brought to bear their experiences to critique the work of others. They also saw how the various elements of the research plan flowed together.

Research Plan Preparation: Having viewed a completed research project plan and completed their own mini-project, students were asked to create their own research proposal based on the template provided the previous week. Preparing this project plan required them to integrate what they had learned from their experiences into their own research. It would also become a document for future reference and continuing development.

Participant Feedback

We asked students to write a one-page write-up about their reflections on how the program has contributed to their knowledge of the field and to their overall professional development. The following themes emerged from the feedback write-ups from the students. Each is followed by representative quote.

Focus on methodologies: "Currently the seminar has taken the focus of methodology techniques that could prove useful for physics education research."

Application of knowledge learned to own research: "When I first started on my project … there was no methodology base to tie the project together. Luckily once learning about methodologies during these seminars, we were able to map together the project to follow multiple stages and develop a well linked project. I have found it useful to learn about multiple types of methodology techniques that could prove useful and incorporate them for the larger picture of the project."

> *Sharing ideas presented by others*: "Group exercise in applying the steps to a 'real' research setting … allowed for solidification of the ideas since we were actually trying to decide how we would apply the methods to a real research project rather than just discussing them in general."

Our Reflections

Based on our own experiences in leading this program, we believe we would like to continue to focus on the multi-methodological framework. Additionally, the program will also provide a mechanism by which experienced graduate researchers train incoming graduate students and thereby hone their own research and teaching skills in the process.

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