COVER SHEET

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Beyond Description: Using Case Study to Test and Refine an Instructional Theory

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"Case study" has many descriptive functions (e.g., case record, discussion stimulus, research report, research tool) and can be used to generate theory. However, case study also has a critical role in testing theory. Here, I discuss a case study that was used to test an instructional theory in mathematics derived from the literature. Theory testing involved operationalising the theory as an intervention and determining support for assertions related to the instructional goals. The case study supported some theoretical components and provided explanations that led to the revision of other components. Hence, case study - beyond description - has analytic generalisability.

Case Study in Education

The term "case study" is variously used in education and refers to processes and products that relate to teaching and research. These applications of "case study" are:

1. *a case record* that, for example, documents an individual's particular learning needs and achievements (e.g., Massachusetts Department of Education, 2002),
2. *a teaching approach* that uses a narrative to stimulate reflection and discussion (e.g., Purdie & Smith, 1999),
3. *a research design* that investigates a particular phenomenon (e.g., Yin, 1994), and
4. *a reporting genre* for research that may be variously structured (e.g., linear analytic) depending on the research and the audience (e.g., Yin, 1994).

Case studies that involve case records, teaching narratives, and case reports are inherently descriptive. Additionally, description is one of the key purposes of case study design (Bassey, 1999; Yin, 1994). Given, the role of description in the various forms of case studies, it is understandable why description and case study are often inextricably linked. However, case study design can also include exploration and explanation (Yin, 1994). Case study design involves "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 1994, p. 13). Descriptive and exploratory designs can involve theory generation (Bassey, 1999; Yin, 1994), but only an explanatory case study design is appropriate for theory testing (Yin, 1994). This paper focuses on the role of an explanatory case study design and theory testing.

Explanatory Case Study Design and Theory Testing

Explanatory case studies are characterised by "how" and "why" research questions because they investigate the relationships that are proposed between components of a theory (Yin, 1994). Inconsistencies between a preliminary theory and the evidence are accommodated in an explanatory case study design by revising the preliminary theory.

The role of explanatory case study design in theory testing is now illustrated using an example of a study on the effect of instruction on primary students' use of diagrams in mathematical problem solving. This study and the instructional theory are described fully elsewhere (Diezmann, 1999). This research topic is significant because although the use of diagrams is strongly advocated as a tool for problem solving (e.g., National Council of Teachers of Mathematics, 2000); students are reluctant to use diagrams (e.g., Yancey, Thompson, & Yancey, 1989); have difficulties with diagram use (e.g., Dufour-Janvier, Bednarz, & Belanger, 1987); and there is scant literature to inform instructional practice (e.g., Shigematsu & Sowder, 1994).

A preliminary theory of instruction was developed to enhance students' use of diagrams in mathematical problem solving. This theory drew on a breadth of literature including diagram use in mathematics, students' knowledge of diagrams, effective instructional programs, and approaches to assessment. This theory consisted of (a) content related to diagram use in problem solving, and (b) an instructional model. The full theory is presented elsewhere (Diezmann, 1999), however, examples of the literature that informed this theory are shown on Table 1.

Table 1
Examples of the theoretical framework of the Instructional Theory

(a) Content related to diagram use in problem solving

- Knowledge of general-purpose diagrams (i.e., networks, matrices, hierarchies, and part-whole diagrams) (Novick & Hmelo, 1993).

(b) Instructional Model

- Instructional tasks (e.g., Henningsen & Stein, 1997)
- Teaching issues (e.g., Carpenter, Fennema, & Franke, 1996)
- Learner issues (e.g., Vygotsky, 1978)
- Classroom interaction (e.g., Orsolini & Pontecorvo, 1992)
- Participant structures, such as group work (e.g., Blumenfeld, Marx, Soloway, & Krajack, 1996)
- Management issues (e.g., Shulman, 1987)

The instructional theory was tested by operationalising it as an instructional program (Diezmann, 2002) and testing a series of assertions that were associated with the learning goals for the program (see Figure 1) (Diezmann, 1999). Consistent with explanatory case study, "how" and "why" research questions guided this study and enabled theory testing.

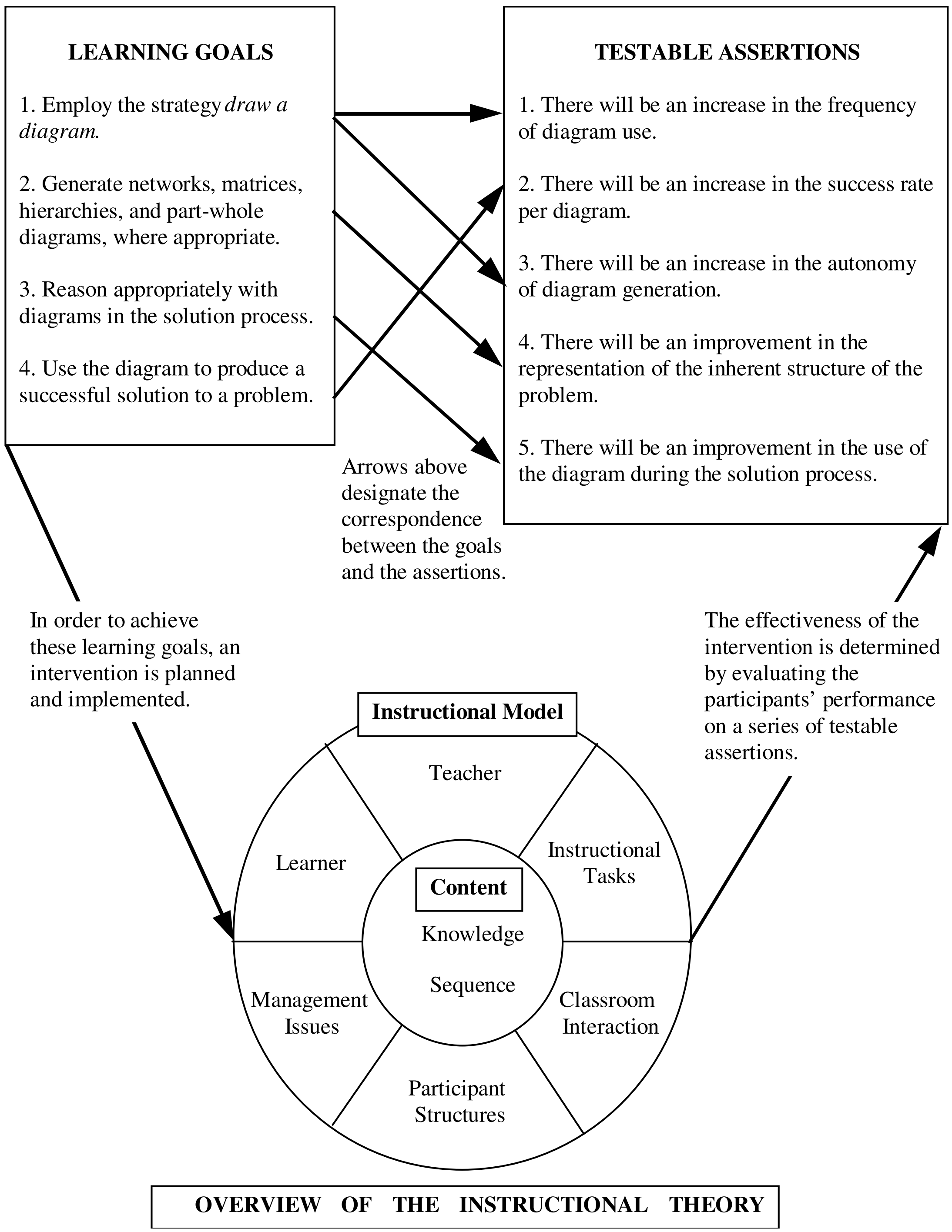

Figure 1: The instructional theory, learning goals, and testable assertions.

The first research question — How will instruction in diagram use affect children's problem solving performance on novel problems? — was investigated through pattern matching (Yin, 1993, 1994) of students' pre- and post-instruction performance on five novel isomorphic tasks. This strategy involved the comparison of students' actual pre- and post-instruction performances and their post-instruction performance predicted by the theory. The testing of assertions examined the relationship between theory and performance through experiment and evidence (Walker & Evers, 1988).

The second research question — Why will instruction in diagram use affect children's problem solving performance on novel problems? — was investigated through explanation building and time-series analysis (Yin, 1993, 1994) using the data from the case database (e.g., interview and lesson videotapes, artifacts, student profiles, lesson observations). Those results that did not fully support the theory were thoroughly investigated. Explanations for anomalous results were developed from the case study database, and where necessary the instructional theory was revised (Yin, 1994).

Conclusion

The explanatory case study, which was employed to test the instructional theory on diagram use, by necessity, went *beyond description.* Theory testing provided the opportunity to ascertain the level of support for the theory from the evidence. Where necessary, the theory was revised to accommodate the evidence (see Diezmann, 1999). Although case studies do not have statistical generalizability, explanatory case studies have analytic generalizability due to the links between theory and evidence (Yin, 1994):

> Case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes. In this sense, the case study, like the experiment, does not represent a "sample", and the investigator's goal is to expand and generalize theories [analytic generalization] and not to enumerate frequencies [statistical generalization]. (p. 10)

Explanatory case study research assumes particular importance in education because it is consistent with the principles of scientific research advocated by the National Research Council (Shavelson & Towne, 2002). Additionally, explanatory research counters criticisms that qualitative research is exploratory, descriptive, lacking in scientific rigor, and not generalizable (e.g., Kilpatrick, 2001).

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