UNIVERSITY OF MINNESOTA

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Advisor

Signature

Date

GRADUATE SCHOOL

A

AN EXPLANATORY MODEL OF PHYSICS FACULTY CONCEPTIONS ABOUT THE PROBLEM-SOLVING PROCESS

A THESIS

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

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PATRICIA HELLER, ADVISOR

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B

DEDICATION

To my parents, Chin-Yi and Yueh-Hsi, for their unwavering love and support throughout this long journey.

To my brother and sister, Andy and Kaitlyn, for putting up with my sometimes eccentric personality during this process.

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ABSTRACT

One commonly stated instructor goal for an introductory calculus-based physics course is to improve students' problem solving skills. There is, however, a growing body of research evidence to suggest that this goal is not frequently accomplished in a typical college or university physics course. In response to this evidence, researchers and curriculum developers have developed a wide variety of curricular materials and instructional strategies that have been shown to be more effective in improving student problem solving performance. In spite of the availability of these curricular materials and instructional strategies, relatively few physics instructors have chosen to use them. One likely reason is that these curricular materials and instructional strategies do not align with, and perhaps are in conflict with, the ways that physics instructors think about the teaching and learning of problem solving. This has led the Physics Education Research and Development Group at the University of Minnesota to undertake a long-term, multi-stage research program to understand physics instructors' conceptions about the teaching and learning of problem solving.

In the first stage, semi-structured interviews with higher education physics instructors in Minnesota were conducted. The interview was designed around three types of concrete instructional artifacts (3 instructor solutions, 5 student solutions, 4 types of problems) that were all based on a single introductory physics problem. The interview included specific questions relating to a particular instructional artifact as well as more general questions. Based on an in-depth analysis of interview transcripts, concept maps were constructed to describe a model of the way that each instructor conceives of the teaching and learning of problem solving. These individual models were combined to form a composite model that describes the range and nature of conceptions for the instructors. The first stage analyzed the interview transcripts of six physics instructors from a research university, and an initial explanatory model was developed. Part of this initial model identified 3 different ways that these instructors conceive of the problem-solving process. Around the same time, interviews were also conducted with 24

additional instructors from community colleges, state universities, and private colleges in Minnesota.

The current study is the second stage of that research program. The goal of this current study is to modify, expand, and refine the part of the initial explanatory model dealing with instructor conceptions about the problem-solving process using interviews with the 24 additional physics instructors. The qualitative analysis procedure of this current study will be a variation of the Grounded Model Construction and Explicit Analysis methods suggested by Clement (2000). The first phases of this analysis will utilize the interviews with the 24 additional instructors. In the first phase, the initial explanatory model will be modified and expanded by adding and/or modifying the different conceptions about the problem-solving process. The second phase of this analysis will be the refinement of the details and descriptions of the modified and expanded conceptions. Concept maps were used both as an analysis tool and to schematically represent instructors' conceptions.

The refined explanatory model of instructor conceptions about the problem-solving process developed in this current study consisted of two qualitatively different conceptions. A third conception of the problem-solving process was also identified in this sample, but it was idiosyncratic, and did not consist of any descriptions of a process. As such, it did not provide very much information for further analysis and comparison. Of the two conceptions that included descriptions of a process, not one instructor expressed both conceptions. Although the instructors in these two conceptions used similar wording in describing various parts of the problem-solving process, they differed in the underlying nature of what problem solving entails. One group of instructors conceived of the problem-solving process in introductory calculus-based physics as linear decision-making. Another group of instructors conceived of the problem-solving process as cyclical decision-making. Furthermore, the instructors in these two conceptions of the problem-solving process also differed in their views of the thinking processes that underlie successful problem solving.

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