FACULTY CONCEPTIONS ABOUT THE TEACHING AND LEARNING OF PROBLEM SOLVING IN INTRODUCTORY CALCULUS-BASED PHYSICS

A THESIS

SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL

OF THE UNIVERSITY OF MINNESOTA

BY

CHARLES ROY HENDERSON

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

PATRICIA HELLER, ADVISOR

JUNE, 2002

UNIVERSITY OF MINNESOTA

This is to certify that I have examined this copy of a doctoral thesis by

CHARLES ROY HENDERSON

And have found that it is complete and satisfactory in all respects,

and that any and all revisions required by the final

examining committee have been made.

PATRICIA HELLER

Advisor

Signature

Date

GRADUATE SCHOOL

DEDICATION

To my wife, Jill Terwilliger, for her love and support throughout this long process.

ACKNOWLEDGEMENTS

I would like to thank the many people whose time, effort, and support were greatly appreciated in the completion of this dissertation.

I thank my advisor, Dr. Patricia Heller, for her guidance and support during this project. She has taught me what it means to conduct research.

I thank Dr. Edit Yerushalmi for her help and support on this project and her keen insight into the teaching/learning process. I have learned much from our conversations.

I thank Dr. Kenneth Heller for his continual advice and encouragement. He has taught me how to give a good presentation.

I thank Dr. Frances Lawrenz for her many helpful conversations throughout this project.

I thank Vince Kuo for his work on this research project and for his editing skills.

Finally, I thank the 6 instructors who agreed to be interviewed as part of this study. Their willingness to talk with me about their views of the teaching and learning of problem solving made this study possible.

ABSTRACT

Researchers and curriculum developers have developed a wide variety of curricular materials and instructional strategies that have been shown to be effective in improving student problem solving performance. Relatively few physics faculty, however, have chosen to use them. One likely reason is that these curricular materials and instructional strategies do not align with the ways that faculty think about the teaching and learning of problem solving.

This study is the first stage of a research program to understand faculty conceptions of the teaching and learning of problem solving. Interviews with six physics faculty from a large research university were used to generate an initial explanatory model of faculty conceptions. The interview was designed around three types of concrete instructional artifacts (3 instructor solutions, 5 student solutions, 4 types of problems).

Based on an in-depth analysis of the interview transcripts, a model of faculty conceptions was developed that consists of 14 general features. The basic relationships between these 14 general features are described in a concept map that is common to all six faculty. For example, there are three distinct ways that faculty think students can learn how to solve physics problems: (1) by solving problems on their own; (2) by using feedback while/after working on problems; (3) by watching someone else solve problems or describe how to solve problems.

Concept maps are also used to describe each of the 14 general features. For some of the general features, all six faculty have similar conceptions. For example, they all classify their students in terms of intelligence/natural ability and learning characteristics (e.g. motivation, study habits, etc.) and use these characteristics to explain why some students succeed and some students fail. For other general features, there is more than one distinct conception. For example, the model shows three different ways that these faculty conceive of the problem solving process: (1) three think of it as a linear decision-making process; (2) two think of it as a process of exploration and trial and error; and (3) one thinks of it as an art form that is different for each problem.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES