HOW TERTIARY LEVEL PHYSICS STUDENTS LEARN AND CONCEPTUALISE QUANTUM MECHANICS

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Dedicated to

Andrew Frank Egan

Who touched the minds and lives of all who came into contact with him.

The more success the quantum theory has, the sillier it looks.

Albert Einstein
PREFACE

This study was conducted in accordance with Human Ethics approval 99/09/21; please refer to Appendix 1 for further details.

A concept mapping exercise developed by Associate Professor Ian Johnston in 1999, designed as a formative assessment task to examine the relationships between key concepts associated with quantum mechanics was selected as one of the four grounded data sources for this study; please refer to Appendix 2 for further details.

Assistance during the coding phases of this study was provided by Associate Professor Ian Johnston, Dr Kirsten Hogg, Mr Stephen Junor, Dr Michael Stewart and Mr Ian Sefton.

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ABSTRACT (300 Word Summary)

Quantum mechanics is an area of immense importance to modern technologies and industries, covering a diverse range of applications from semiconductors and lasers to advances in nuclear medicine. Quantum mechanics is also a subject that most students have traditionally found both difficult and abstract. Despite these facts, quantum mechanics has not until recently attracted much pedagogical research and introductory courses are still taught in much the same manner as they have been for the past seventy five years. The aims of this research project are to isolate key concepts, to identify learning difficulties, to identify teaching difficulties, and so to provide both teachers and curriculum developers with a useful resource to assist them in making informed decisions. The research was conducted in two distinct stages: Stage 1 – The Grounded Theory Approach was used to develop a set of interview questions, their content and sequencing was grounded in the data collected from a range of sources including concept maps, expert interviews, examination scripts and preliminary interviews. Stage 2 – The Phenomenological Approach primarily conducted and analysed 48 one hour student interviews, generating a tabulated dataset which is divided into 5 themes. In reporting these results, attention is then drawn to facts and trends within these themes. Additionally, the discussions with lecturers, which were conducted during the grounded phase of the investigation, were also brought forward to compare, contrast and support the results under discussion. In conclusion three outcomes of this investigation are acknowledged: A Detailed Data Resource that provides a readily accessible resource which details the internal aspects of the five identified themes; A Framework in the form of a schematic representation, comprising the three areas of Mathematics, Quantum Concepts and Outside Applications, providing the teacher and/or researcher with a tool to examine how the structural and thematic components are related, and; A Research Methodology which provides an easily adaptable and robust research tool for investigating similar physics education research questions within a tertiary setting. Three research topics are proposed for future investigation.
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