

**UNIVERSITI TEKNOLOGI MARA**

**EXPLORING HEAT EQUATION WITH  
VARIOUS BOUNDARY CONDITIONS  
USING SOV THROUGH 'HEAT  
MASTER' LEARNING APPLICATION,  
P28S23**

**AIDA AFRINA KHUSLI, NUR ANIS IZZATI  
ABDULL RAZAK & NUR ANIS NATASHA  
ZAHURIN**

Report submitted in partial fulfillment  
of the requirements for the degree of  
**Bachelor of Science (Hons.)**  
**(Mathematics)**

**College of Computing, Informatics & Mathematics**

**January 2024**

## ABSTRACT

Partial differential equation (PDE) is a mathematics concept that is often considered a difficult topic among undergraduate students and frequently associated with complications and hardly seen in relation to the real world. Therefore, this study focuses on the intersection of mathematical modeling, educational technology, and innovative pedagogical strategies, centering on the heat equation pivotal partial differential equation (PDE) used to describe heat distribution in various boundary conditions. The study aims to change and eliminate the perception of mathematics as a difficult and uninteresting subject by designing and developing an interactive learning application called 'Heat Master'. The study applies the Separation of Variables method, followed by the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) method to develop a Heat Master. An evaluation of its engagement takes place by distributing a set of validated questionnaires to 50 respondents. The respondents' feedback, analyzed using SPSS, reveals a favorable mean value of 3.59. 'Heat Master' is now ready to use and assist learners in understanding the concept of PDE.

## ACKNOWLEDGEMENT

In the name of Allah, the most gracious, the most merciful.

We extend our deepest appreciation to those who have been pivotal in completing our Final Year Project (FYP), making this journey truly rewarding. Special recognition goes to our main supervisor, TS. DR. Ratna Zuarni Ramli, whose unwavering support and insightful guidance were invaluable. The expertise and encouragement of our co-supervisor, Dr. Siti Hidayah Muhad Saleh, significantly contributed to refining the quality of our work. We are also deeply grateful to Sir Mohd Azdi bin Maasar, our FYP subject supervisor, for providing specific guidance and relevant feedback that significantly enhanced the depth and relevance of our research.

Moreover, our heartfelt thanks extend to the entire academic community that fostered an environment conducive to learning and exploration. The collaborative spirit among fellow students, the insightful discussions with classmates, and the resources provided by the institution have all contributed to the richness of our research experience.

Additionally, we express gratitude to our families and friends for their unwavering support and encouragement throughout the challenging yet fulfilling process of completing this project. The synergy of these diverse elements, including mentorship, academic community support, and personal connections, has not only elevated the quality of our final-year project but has also left a lasting impact on our academic journey. As we conclude this chapter, we look forward with gratitude and optimism, knowing that the lessons learned, and the relationships forged will continue to shape our academic and professional endeavors in the future. May Allah's blessings be upon all who have contributed to the success of our Final Year Project.

# TABLE OF CONTENTS

	<b>Page</b>
<b>SUPERVISOR'S APPROVAL</b>	<b>i</b>
<b>AUTHOR'S DECLARATION</b>	<b>ii</b>
<b>ABSTRACT</b>	<b>iii</b>
<b>ACKNOWLEDGEMENT</b>	<b>iv</b>
<b>TABLE OF CONTENTS</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>viii</b>
<b>LIST OF FIGURES</b>	<b>ix</b>
<b>LIST OF SYMBOLS</b>	<b>x</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xi</b>
<b>CHAPTER ONE: INTRODUCTION</b>	<b>1</b>
1.1 Research Background	1
1.2 Problem Statement	2
1.3 Research Objectives	3
1.4 Significance of Study	3
1.5 Limitations	4
1.6 Scope of Study	5
1.7 Definitions of Terms	5
<b>CHAPTER TWO: LITERATURE REVIEW</b>	<b>8</b>
2.1 Partial Differential Equation	8

2.1.1	Separation Of Variable (SOV)	8
2.1.2	The Heat Equation: Foundations and Significance	8
2.2	Previous Studies: PDEs, Heat Equations, and SOV	9
2.3	Effects of Learning Application in Mathematics	11
2.3.1	Students Engagement in Educational Application	11
2.3.2	Gamification and Game Elements	12
2.4	Previous Studies: Effects, Students Engagement and Gamification in Learning Application	12
<b>CHAPTER THREE: RESEARCH METHODOLOGY</b>		<b>14</b>
3.1	Methodology	15
3.1.1	Phase 1	15
3.1.2	Phase 2	16
3.1.3	Phase 3	17
3.2	Implementation	18
3.2.1	Phase 1: Identify Boundary Value - Problem (BVP)	18
3.2.2	Phase 2	20
3.2.3	Phase 3	47
<b>CHAPTER FOUR: RESULTS AND DISCUSSIONS</b>		<b>49</b>
4.1	Results of Maple for Deriving the Heat Distribution Equation using the Separation of Variables (SOV) Method	49
4.1.1	BVP 1	49
4.1.2	BVP 2	50
4.1.3	BVP 3	51
4.1.4	BVP 4	53
4.2	Analysis of data from the evaluation of students' engagement	54
4.2.1	Demographic Analysis	54
4.2.2	Analysis of Reliability and Validity	54
4.2.3	Students Engagement Analysis	55
<b>CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS</b>		<b>58</b>
5.1	Conclusion	58